REPUBLIC OF KENYA

KISII COUNTY GOVERNMENT

ARAB BANK FOR ECONOMIC DEVELOPMENT IN AFRICA

SAUDI FUND FOR DEVELOPMENT

M I N I S T R Y O F H E A L T H

BIDDING DOCUMENTS

For Procurement of

PROPOSED CANCER CENTRE AT THE KISII TEACHING AND REFERRAL HOSPITAL
Mechanical Works
(AIR CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS)

TENDER NO.: MOH/NCCP/ICB/013/2023-2024

2 OF 5

CLOSING DATE: 5TH APRIL 2024 AT 10.00 A.M. LOCAL TIME

SCHON ASSOCIATES

NARCO ENGINEERING CONSULTANTS

DR. NABEEL ABDUL-RAHEEM CONSULTANTS

Issued on: 20th February 2024

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TECHNICAL SPECIFICATION AND BILLS OF QUANTITIES

FOR

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

TABLE OF CONTENTS

INVITATION FOR TENDER

COUNTRY:	**KENYA**
PROJECT NAME:	**CONSTRUCTION AND EQUIPPING OF A NEW CANCER DIAGNOSTIC AND TREATMENT CENTRE AT KISII TEACHING AND REFERRAL HOSPITAL**
TENDER NO:	**MOH/NCCP/ICB/013/2023-2024**
TENDER NAME:	**AIR CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS**
CLOSING DATE:	**5TH APRIL 2024 AT 10:00 A.M. KENYAN TIME**

1. The Government of the Republic of Kenya has obtained a loan from the Arab Bank for Economic Development in Africa and the Saudi Fund for Development to finance the Construction, Equipping and Commissioning of a new Cancer Diagnostic and Treatment Centre at Kisii Teaching and Referral Hospital and it is intended that part of the proceeds of the said loan will be applied towards the costs of the Works.
2. The Ministry of Health invites sealed Tenders from eligible Tenderers for the Construction, Equipping and Commissioning of a new Cancer Diagnostic and Treatment Centre at Kisii Teaching and Referral Hospital (hereinafter called the Works) and the remedying of any defects therein.
3. Eligible interested Tenderers may obtain further information, addendums or clarifications in respect to this Tender from the Ministry website www.health.go.ke. All eligible Tenderers are advised to regularly check the website during the bidding period.

4. A complete set of the Tender documents may be downloaded from the Ministry's website www.health.go.keor public procurement information portal: www.tenders.go.ke, free of charge. Eligible Tenderers downloading the Tender document MUST forward their company's details to procurement@health.go.ke so that any addendum/ clarifications can be sent to their email address.

   Requests for clarification to be sent either by mail to Principal Secretary, Ministry of Health P. O Box 30016 Nairobi, Kenya or through email address procurement@health.go.ke, at any time, but not later than 14 days before the closing date for submittal of bids.

   The Tender is comprised of the following:

Tender	Tender Number	Name of Tender
4.	MOH/NCCP/ICB/013/2023-2024	Air Conditioning and Mechanical Ventilation Installations

   Interested bidders may participate on their own or as a joint venture. All partners of the joint venture shall be liable jointly and severally for the execution of the contract in accordance with the contract terms. A copy of the agreement entered into by the joint venture partners shall be submitted with the tender.
5. A Pre-Tender site visit will be held at the *site located opposite Kisii School along Kericho-Kisii Highway on* ***Monday, 11th March 2024 at 09:00 a.m****. The site has a conspicuous signpost that reads "Proposed Kisii Cancer Centre".*
6. The **original** and **one copy** of the Tender Document shall be placed inside of a sealed envelope, clearly marked with, "[Name of the TENDER] ", reference number with a warning "**Do Not Open until** [***5th April 2024*** *at* ***10.00 a.m.*** **(Kenyan Time**)].
7. If the envelopes and packages with the tenders are not sealed and marked as required, the Client will assume no responsibility for the misplacement, loss, or premature opening of the tender.
8. Every Tender must be accompanied by a **Tender Security of 2% of the Total Tender Amount** or equivalent amount in the currency of the Tender.
9. Tenders must be delivered to the address below,

   The Principal Secretary,
   Ministry of Health,
   Afya House Building, Cathedral Road,
   P.O. Box 30016-00100,
   NAIROBI.

   or be deposited in the Tender Box located on 1st Floor of Afya House, Ministry of Health, Cathedral Road, Nairobi, so as to be received on or before ***10:00 a.m. on 5th April 2024***.

   Electronic bidding will *not* be permitted. Late tenders will be rejected.

10. Tenders will be opened immediately thereafter at the GTZ Boardroom located at Afya House Ground Floor.

Head Supply Chain Management Services

For: Principal Secretary

SECTION 1:
SIGNATURE PAGE & SPECIAL NOTES
KISII CANCER CENTRE - KISII COUNTY, KENYA

SUB-CONTRACTOR QUALIFICATION INFORMATION

BID ELIGIBILITY AND QUALIFICATION CRITERIA

The following criteria will be used in the evaluation of all bids. The submission of the required documents will be used in the determination of the Completeness and Suitability of the Bid. Bids that do not contain all the information required will be declared non-responsive and shall not be evaluated further.

A. MANDATORY EVALUATION

ITEM	MANDATORY REQUIREMENT	YES	NO
1	Copy of Certificate of Registration/Incorporation		
2	Copy of Valid Tax Compliance Certificate from Country of Residence		
3	Copy of valid business permit or International equivalent		
4	Copy of Valid Registration with National Construction Authority (NCA) for Mechanical (Class 1) or equivalent International standard, include relevant licenses, registration, and certifications		
5	Attach copies of Recommendation letters from three of your major clients having undertaken similar assignment		
6	Show proof of Local/Regional presence		
7	Certified copy of valid contractor's annual NCA practicing license for Mechanical works or equivalent International Standard		
8	Certified copy of Company Record showing shareholders (CR12 or Equivalent)		
9	Audited Accounts for the last three years		
10	Proof of having completed at least one relevant project valued at One million USD and above for Hospital Air Conditioning and Mechanical Ventilation completed in the last 10 years. Attach relevant project documents to show proof of project completion.		
11	Technical specifications of all the equipment proposed as laid out in the Specifications and Drawings. Include Brochures and Catalogues.		
12	The Bidder shall provide details of line(s) of credit available to the bidder, including amount(s) and name of bank(s) making available such line(s) of credit		
13	The Bidder shall provide letter(s) authorizing the Employer to seek references from the bidder's bankers		
	PASSED (RESPONSIVE)		
	FAILED (NON-RESPONSIVE)		

NOTE: **Failure to comply with Mandatory requirements will lead to automatic disqualification.**

Only bidders who are successful at this stage will proceed to the next stage of evaluation.

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TECHNICAL SPECIFICATION AND BILLS OF QUANTITIES

FOR

AIR-CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

Preamble

Supplied as part of the Main Tender for the Air – Conditioning and Mechanical Ventilation Installations at PROPOSED KISII CANCER CENTER – AT KISII COUNTY

.

ISSUED BY:

The Principle Secretary
Ministry of Health
P.O. Box 30016 - 00100,
Nairobi, Kenya.

PREPARED BY:

Schon and Associates,
P.O. BOX 38601-00100,
Nairobi, Kenya.

The Tender for the above-mentioned works dated this_____ day of _____2024 by the undersigned parties refers to the Bills of Quantities consisting of the pages numbered on contents page.

.....	.....
SUB-CONTRACTOR	MAIN CONTRACTOR
Date 2024	Date 2024

SIGNATURE PAGE

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TENDER FOR AIR – CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

SPECIAL NOTES

1. The Tenderer shall tender for the above Works in accordance with the appended drawings, Technical Specification and Bills of Quantities.

2. The Tenderer is required to check the numbers of the pages of these Bills of Quantities against the contents stated on Page 1-i and should he find any missing, in duplicate or illegible he must inform the Engineer at once and have the same rectified.

3. Should the Tenderer be in doubt about the precise meaning of any item or figure, for any reason whatsoever, he must inform the Engineer in order that the correct meaning may be decided before the date for submission of the tenders.

4. No liability will be admitted or claim allowed in respect of errors in the Tenderer's tender due to mistakes in the Bills of Quantities that should have been rectified in the manner described above.

5. The annexed Bills of Quantities must be fully priced in ink. The Tenderer shall not alter or otherwise qualify the text of these Bills of Quantities. Any alteration or qualification made without authority will be ignored and the text of the Bills of Quantities as printed will be adhered to.

6. **Fully priced Bills of Quantities must be accompanied by brochures and technical literature for the major mechanical and electrical items.**

7. The Tenderer shall be deemed to have made allowance in his prices generally to cover items of Preliminaries or additions to Prime Cost Sums or other items, if the Tenderer has not priced these where appropriate.

8. All items of measured work shall be priced in detail and tenders containing lump sums to cover trades or groups of work must be broken down to show prices of each item before they will be accepted. Lump sums to cover items of Preliminaries shall be likewise broken down if so required.

9. This tender shall be exempted from **all taxes and duties** as imposed by Kenya Revenue Authority or any other Statutory Authority in Kenya having jurisdiction over the works.

10. Under no circumstances will any expense incurred by Tenderers in preparation of this tender be allowed.

11. The copyright of these Bills of Quantities is vested in the Engineer and no part thereof may be reproduced without express permission given in writing by the Engineer.

12. The Tenderer is solely responsible for the accurate ordering of materials in accordance with the Drawings and Engineer's instructions and no claim for any loss or expense will be entertained for orders for materials based upon the Bills of Quantities.

13. The successful tenderer shall be appointed as a **NOMINATED SUB – CONTRACTOR under the FIDIC Conditions of sub-contract for construction for building and engineering works designed by the employer**

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TENDER FOR AIR – CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

CONDITIONS OF TENDERING

1.01 Each Tenderer must submit, enclosed in a plain sealed envelope clearly marked, "TENDER FOR AIR – CONDITIONING AND MECHANICAL VENTILATION WORKS FOR THE PROPOSED KISII CANCER CENTRE – KISII COUNTY". The Tenderer shall enter his tender sum on the prescribed Tender Form.

1.03 Each Tenderer must submit the name of a Surety who shall be an established Bank, willing to be bound to the Tenderer in the sum equal to ten per cent (10%) of the tender sum for due performance of the Contract and must submit together with his tender the form attached thereto duly filled in and signed by the proposed Surety agreeing to sign a Bond to that effect when and if called upon to do so. **A Surety from an insurance company will not be accepted**.

1.04 Tenders and all the Documents in connection therewith as specified above must reach the Address as advised and on the date stated in the covering letter accompanying these documents.

1.05 In the case of a tender not being delivered by hand, the Tenderer must arrange for his tender and other documents to be posted in time to reach the above office not later than the stipulated time.

1.06 Any tender delivered after the stipulated time, from whatever cause arising, will be disqualified.

1.07 In no case will any expense incurred by the Tenderer in the preparation of his tender be allowed.

1.08 Tenders shall remain valid for One Hundred and Twenty (120) days from the final date of submission of tenders stipulated in Paragraph 2.01 above, and no Tenderer may withdraw his tender after that period.

1.09 The Employer shall not be bound to accept the lowest or any tender and shall not be bound to give reasons for his decision.

1.10 The Engineer shall notify the accepted approved Tenderer (if any) of such acceptance by letter within One Hundred and Twenty (120) days during which, by Paragraph 3.01 thereof, the tender is to remain valid and the said Tenderer shall then within the time stated in the Form of Tender first execute the formal Contract Agreement and then on the same day his approved Surety shall sign the Bond. The Engineer however, reserves the right to extend the period for executing the formal Contract Agreement if satisfied that adequate reasons exist for so doing.

1.11 Every notice to be given to a Tenderer may be posted to the Tenderer's address as given in his tender and such posting shall be deemed to be good service of such notice.

1.12 The term "Electrical and Mechanical Engineer" wherever used in these Conditions and in all Contract, Documents shall be such person or persons as may be duly authorized to represent M/s Schon Associates.

1.12 The words "Approved Tenderer" in these Conditions shall mean that the Tenderer shall be approved by the Employer as having complied with these Conditions in every respect.

1.13 The word "Tenderer" in these Conditions shall be deemed where applicable to include two or

more persons. The word "his" may also mean "their" and the word "he" may also mean "they".

1.14 If it is found on the examination of a tender that there is a discrepancy between the Total Amount of the tender and the amount arrived at by valuing the quantities set out in the Bills of Quantities at the rates or prices set against them by the Tenderer, then the figures shall be corrected arithmetically and the differences between the tender and the corrected total shall be applied as a percentage adjustment or addition or omission on all the rates, so that the original tender amount remains unaltered. When calculating the percentage adjustment, the total cost of the Preliminaries, Provisional and P.C. Sums, Contingencies and any other items of a similar nature shall be excluded.

1.15 If it is found on examination, that any rates for the work appear to be unreasonable then the attention of the Tenderer shall be drawn to any such items. If as a result of this, the Tenderer asks for any rates to be changed, then the arithmetical effect of any change will be adjusted in accordance with sub-paragraph 8.01 above.

1.16 Non-compliance with the above Conditions in any respect shall render the tender liable to rejection.

FORM OF TENDER

To:

Principle Secretary
Ministry of Health,
P.O. Box 30016- 00100
Nairobi, Kenya.

Sirs,

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TENDER FOR AIR – CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

1.01 Having visited the site and examined the tender documents for the execution for the above works I/We

…….

(Names) under and subject to the Conditions of Tendering annexed hereto, hereby tender and offer to execute and perform the works and provisions and supply all labour and materials and everything of every kind respectively named, shown, described and alluded to in, or to be inferred from the **FIDIC Conditions of sub-contract for construction for building and engineering works designed by the employer**, the General Conditions of Sub-Contract, Specification and Bills of Quantities, Drawings and conditions of contract to be executed and supplied on the part of the Sub-Contractor, for the Works above described for the Sum of:-

Fixed /Non Fluctuating Price Tender (Adjusted fluctuating price to allow for future price changes). Tender figure, Prime Cost & Provisional sums and Contingencies.

Amount in figures (USD): . . . .

Amount in words (USD): . …… . . . . . .

. . . . ……

1.02 I/We agree to phase the sub-contract work in accordance with the building programme to be agreed with the main Contractor at the time of letting the Main and Sub-Contracts.

1.03 I/We further agree to be bound by and submit to the said General Conditions of Sub-Contract and priced Specification and Bills of Quantities which shall form a basis for valuation of interim Certificates and any extra or omitted work which may from time to time be ordered by the Architect.

1.04 We have examined all the documents, which will form part of this contract and have no further questions relating to them.

2.01 I /We submit the name of ……

Address ……

as a Surety who is willing to be bound to the Main Contractor in an amount equal to 10% of the Sub-Contract amount for the due performance for the Sub-Contract up to the date of completion of the Works as certified by you, and who will, when and if called upon, sign a Bond to that effect without limitations on the same day as the Sub-Contract Agreement is signed, but thereafter, and in the

event of the Surety named herein not being approved by you, the undersigned agree(s) to furnish within seven (7) days another Surety to your approval.

3.01 Whereas it is understood that you reserve to yourself the right to accept or to refuse this tender whether it be lower or higher than any other tender, or of the same amount, the undersigned agree(s) that this tender shall remain valid and shall not be withdrawn within One Hundred and Twenty (120) days from the final date for the submission of Tenders stipulated in the Conditions of Tendering.

4.01 And further, the undersigned agree(s), in the event of your acceptance of this tender, to execute the formal Sub-Contract Agreement within seven (7) days from posting, or delivery if by hand, of notification of acceptance.

Signature of Tenderers: ……

Name of Tenderer: ……..

Address: ……..

Date: ……

Signature of Witness: ……...

Name of Witness: ……

Address: ……..

Date: ……..

NOTE: Tenderers are not required to attach the Surety Undertaking, duly signed by the Surety, to this Form of Tender. However, a performance bond will be executed on being successful before contract signature.

DECLARATION ON AVAILABILITY OF MATERIALS, PLANT, SUPERVISION AND SKILLED LABOUR

To: The Principle Secretary
Ministry of Works
P. O. Box 30016 – 00100
Nairobi, Kenya

Sirs,

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TENDER FOR AIR – CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

In connection with the attached tender for the above Sub-Contract, I/We have made full enquiries with manufacturers and/or distributors of the relevant materials and plant required to be incorporated or used in the Works and I/We hereby declare that I/We will have available: -

*(a) all the necessary
or *(b) a proportion of the necessary

Materials, plant, tools and equipment, supervision and skilled labour

*(a) from stocks in hand
or *(b) from sources of supply available to me/us
for use as and when they are required for the Works.

Signature of Tenderer …….

Name of Tenderer ……...…….

Address ……...……...

Date…….

NOTES: -

1. *Delete whichever is not applicable.
2. *The Tenderer may be required before approval

(a) To disclose the (i) actual quantities of the various materials and (ii) plant available for immediate use and, (iii) To submit names and CV's and academic certificates of available supervision personnel and team leader being a mechanical engineer with over 10 years' experience, (iv) Skilled labour.

b) To give details of the arrangements which have been made by the Tenderer for the obtaining and delivery to the site of the further materials and plant and employment of supervision and skilled labour required to complete the works.

3. Failure to satisfy the Engineer that adequate arrangements have been made to provide or obtain the whole of the materials, plant, tools and equipment necessary to complete the Works within the contract period or such extended period as may be authorized, may render the Tenderer liable to be considered in default.

SURETY UNDERTAKING

PROPOSED KISII CANCER CENTER – AT KISII COUNTY
TENDER FOR AIR CONDITIONING AND MECHANICAL VENTILATION

We …… (Surety)

of P.O. Box ……

hereby undertake to provide a guarantee in the form of Performance Bond supplied with these tender documents, under seal if so required, for the due performance of the contract to the extent to ten percent (10%) of the awarded contract sum in the event of

……(tenderer)

of (address) ……..

being awarded the tender for construction and completion of the project including twelve (12) months maintenance.

We further agree to execute a Performance Bond under the forgoing terms within FOURTEEN (14) DAYS of being called upon to do so.

Should the said tenderer not be awarded the contract, it is understood that this offer shall become null and void.

Signed for and on behalf of surety …….. (Authorised signatory)

Name & address of surety (official rubber stamp)

……

Date signed ……..

CONFIRMATION OF SUFFICIENCY OF INFORMATION PROVIDED / SITE VISIT

This is to certify that we _____
(Name of Tenderer)

of the firm of _____

(Name of firm tendering)

Having studied the contract documents, have made our selves familiar with all local conditions likely to influence the works and cost thereof.

We undertake to treat all provided information with strict confidentiality.

We further certify that we are satisfied with the description of the works and explanations given and confirm as follows:

We visited the site on _____and confirmed all necessary information.

We did not visit the site but confirm sufficiency of provided information:

_____ _____

Signed (Name & Signature of Tenderer)

PERFORMANCE BANK GUARANTEE

PROPOSED KISII CANCER CENTER – AT KISII COUNTY
TENDER FOR AIR CONDITIONING AND MECHANICAL VENTILATION

To:

Principle Secretary
Ministry of Health,
P.O. Box 30016- 00100
Nairobi, Kenya.

(Date)

Dear Sir,

WHEREAS…… (Hereinafter called "the Contractor") has undertaken, in pursuance of Contract for …… to execute (herein after called the “works”)

AND WHEREAS it has been stipulated by you in the said Contract that the Contractor shall furnish you with a Bank Guarantee by a recognized bank for a sum specified therein as security for compliance with his obligations in accordance with the Contract;

AND WHEREAS we have agreed to give the Contractor such a Bank Guarantee:

NOW THEREFORE we hereby affirm that we are the Guarantor and responsible to you, on behalf of the Contractor, up to a total of USD…….

(Amount of Guarantee in figures) USD…… ……

(amount of Guarantee in words), and we undertake to pay you, up to your first written demand and without cavil or argument, any sum or sums within the limits of USD …… …….. (Amount of Guarantee in words) as aforesaid without your needing to prove or to show grounds or reasons for your demand for the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change, addition or other modification of the terms of the Contract or of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this Guarantee, and we hereby waive notice of any change, addition, or modification.

This guarantee shall be valid until the date of issue of the Certificate of Completion.

SECTION 2:

PRELIMINARIES

KISII CANCER CENTRE - KISII COUNTY, KENYA

PROPOSED KISII CANCER CENTER – AT KISII COUNTY

TENDER FOR AIR CONDITIONING AND MECHANICAL VENTILATION INSTALLATIONS

PRELIMINARIES

PRELIMINARIES

A ABBREVIATIONS

Throughout these Bills, units of measurements and terms are abbreviated and shall be interpreted as follows: -

"m^3"	Shall mean Cubic Metre
"m^2"	Shall mean Square Metre
"Lm or m"	Shall mean Linear Metre
"Lbs."	Shall mean Pounds Weight Avoirdupois.
"kg"	Shall mean Kilogram.
"No."	Shall mean Number.
“P.Sum”	Shall mean Provisional Sum
“Sum”	Shall mean Lump Sum
"Prs."	Shall mean Pairs.
“LV”	Shall mean Low Voltage

"Do." or “ Ditto” Shall mean the whole of the preceding description except as qualified in the description in which it occurs. Where it occurs in descriptions of succeeding items it shall mean the same as in the first description concerned. Where it occurs in brackets it shall mean the whole of the preceding description which is contained within the appropriate brackets. Where it is underlined it shall mean the whole of that part of the preceding description which is underlined.

The full titles of the Standards referred to in this document are as follows:

BS	- British Standards
IEC	- International Electrotechnical Commission
IEE	- Institution of Electrical Engineers
ISO	- International for Standardization Organization
CIE	- International Standard on Illumination
EN	- European Committees for Standardization
CECC	- European Committee for Electrotechnical Standardization
DIN	- Deutsches Instut fur Norming
KEBS	- Kenya Bureau of Standards

A ALTERATIONS TO TEXT ETC.

Any unauthorised alteration or qualification made to the text of this document may cause the tender to be disqualified and will, in any case, be ignored.

Each item in the Bills of Quantities must be priced and tenders containing Lump Sums to cover groups of work must be broken down to show the price of each item before they are accepted. Lump Sums to cover any items of Preliminaries shall be broken down if so required by the Engineer.

B DEFINITION OF TERMS

(i) "SELECTED, DIRECTED, APPROVED", ETC

Wherever the words "Selected", "as directed", "as required" or words of similar meanings are used in the Bills of Quantities, it is to be understood that the selections, direction or requirements of the Engineer are intended. Similarly, the words "approved" "satisfactory" or other synonymous words shall mean "approved by" or "satisfactory to" the Architect and the Engineer's approval must first be obtained before the materials are ordered or the works to which the words refer are put in hand.

(ii) "NECESSARY, PROPER" ETC.

Wherever the words "necessary", "proper" or words of similar meaning are used in these Bills of Quantities with respect to the extent, conduct, character or works described, it is to be understood that they shall mean that the said works shall be executed to the extent, must be conducted in a manner or be of a character which is "necessary" or "proper" in the opinion of the Engineer.

(iii) SINGULAR AND PLURAL

Words importing the singular only wherever used hereinafter and in all contract Documents shall also include the plural and vice versa where the context requires.

(iv) EMPLOYER

The Employer is Ministry of Health P.O. Box P.O Box 30016-00100, Nairobi, Kenya. The terms "Employer" and "Client" wherever used in these Contract document shall be synonymous.

(v) ARCHITECT

The term "Architect" shall be deemed to mean the firm of Messrs Schon and Associates P.O Box 38601 - 00100 Nairobi, Kenya

(vi) CIVIL / STRUCTRUAL ENGINEER

The term "The Engineer" shall be deemed to mean the firm of Messrs. Schon and Associates P.O.Box 38601 - 00100, Nairobi, Kenya.

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(vii) ELECTRICAL & MECHANICAL ENGINEER

The term "The Engineer" shall be deemed to mean the firm of Messrs. Schon and Associates P. O. Box 38601 -00100,Nairobi, Kenya.

(viii) QUANTITY SURVEYOR

The term "The Quantity Surveyor" shall be deemed to mean the firm of Messrs Schon and Associates, P.O. Box 38601 - 00100, Nairobi, Kenya.

(ix) MAIN CONTRACTOR

The term "Main Contractor" shall be deemed to mean the person or persons, partnership, firm or company whose tender for the Main Contract works has been accepted, and who has or have signed the Main Contract and shall include his or their heirs, executors, administrator, assignees, successors and duly appointed representatives.

(x) SUB-CONTRACTOR

The term “Subcontractor” shall be deemed to mean the person or persons, partnership firm or company who’s tender for this work has been accepted and who has or have signed this Sub-Contract and shall include his or their heirs, executors, administrator, assignees, successors and duly appointed representatives.

A SITE

The site of the Proposed Kisii cancer centre is in Kisii County, Kenya On plot LR No. ……..

The Tenderer is recommended to visit the site and if unable to locate he shall apply to the Engineer for directions. The Tenderer shall be deemed to have examined and fully acquainted himself with the site and its nature and position, means of access, existing water and electricity supplies, etc. and make all necessary allowances and provisions for overcoming any difficulties which may arise therefrom as no claim for lack of knowledge in this or any other respect will be allowed.

No claims will be allowed for travelling or any other expenses which may have been incurred by the Sub-Contractor in visiting the site or preparing the tender for the Works.

B PRICING OF PRELIMINARIES AND BILLS OF QUANTITIES

Wherever in the Tenderer's priced Preliminaries and Bills of Quantities no price appears against an item, the value of such item shall be deemed to be included in his rates for the other items which have been priced by him.

C FORM OF SUB-CONTRACT

(i) The successful Tenderer will be appointed as nominated Sub-Contractor to the Main Contract under **Clause No. 5.2 of the conditions of Contract for Building and Engineering Works Designed by the Employer (Second Edition (2017) published by International Federation of Consulting Engineers (FIDIC).**

(ii) He will be required to enter into a Sub-Contract with the Contractor indemnifying him against the same liabilities in respect of the Sub-Contract as those for which the Contractor is liable to indemnify the Employer under this contract.

(iii) The Nominated Sub-Contractor will be required to enter into a written Sub-Contract Agreement with the Main Contractor on the latest edition of the ***FIDIC Conditions of sub-contract for construction for building and engineering works designed by the employer***, a signed copy of which must be deposited with the Engineer.

(iv) Copies of the Main Contract Agreement, Conditions of Contract, Bills of Quantities for the Main Contract, Form of Bond, Drawings and the General Specification are available for inspection at the offices of the Engineer on any working day until the time appointed for the submission of the tenders.

(v) If the Tenderer considers that compliance with any of the Condition of Sub-Contract of which the headings are set out hereunder involves him in expense which is not included elsewhere in his prices he shall set down opposite any such condition the value he attaches thereto. The Clause headings of the Schedule of Conditions are set out hereunder but do not in any way affect or restrict the full meaning of the Conditions as printed.

Clauses

1. Sub-Contract Sum
2. Notice of the Main Contract to the Sub-Contractor
3. Execution of the Sub-Contract Works
4. Sub-Contractor's liability under incorporated provisions of the Main Contract
5. Insurance against injury to persons and property
6. Damage by Fire
7. Policies of Insurance
8. Variations, etc
9. Completion
10. Defects, shrinkages, etc
11. Sub-Contract Sum - Valuation of Variations
12. Certificate and Payments
13. Interim Payments to the Sub-Contractor
14. Retention Money
15. Dispute as to Certificate
16. Right of Sub-Contractor to suspend execution of Sub-Contract Works
17. Special Interim Payment
18. Final Payment to the Sub-Contractor
19. Sub-Contractor's claim to Rights and Benefits under the Main Contract
20. Contractor's right to deduction or set off
21. Right of Access of Contractor and Architect
22. Subletting of Sub-Contract Works
23. Provisions of Water etc for Sub-Contract Works
24. Temporary workshops etc
25. Sub-Contractor's use of scaffolding
26. Contractor and Sub-Contractor not to make wrongful use of or interference with the property of the other
27. Plant, tools etc of Sub-Contractor
28. Determination of this Sub-Contract by the Contractor
29. Determination of this Main Contract
30. Wages and Conditions
31. Bond
32. Fluctuations in Duties and Exchange Rates
33. Arbitration

Carried to Collection USD.

A PARTICULARS OF INSERTIONS TO BE MADE IN APPENDIX TO THE SUB – CONTRACT AGREEMENT.

The following are the insertions to be made in the Appendix to the Sub-Contract Agreement:-

Clause 4.2	Sub contract performance security	10% of Contract Sum
Clause 8.1	Commencement of sub-contract works	To be advised
Clause 8.2	Sub – contract time for completion	To be advised
Clause 11.2	Sub contract defects notification period	Twelve (12) months
Clause 14.2	Sub – contract advance payment	To be advised
Clause 14.6	Sub – contract payments	To be advised

B COMPLETION PERIOD

The Date of Completion for the Sub-Contract will be the same as the Date of Completion for the Main Contract.

Carried to Collection USD.

A BOND & STAMP CHARGES

All tenderers will submit the name of an approved Surety who will be willing to be bound to the Main Contractor in an amount as required in the Main Contract Conditions. The Sub-Contractor shall allow for payment of all stamp charges in connection with Surety Bond and Sub-Contract Agreement.

B LICENSING & SUBLETTING

The tenderers for this Sub-Contract must be fully licensed Contractors under the Ministry of Public Works Regulations and must be currently registered as approved Mechanical Contractors Category A with the Contract and Quantities Branch of the Ministry. They must also be registered under the Ministry of Energy as Electrical Contractors as Class A licence. No sub-letting or assignment by non-registered firms will be authorised by the Architect.

C PROGRAMME

All Sub-Contract Works must be programmed and co-ordinated with the approval of the Main Contractor and the Architect. The successful tenderer will be required to submit a programme within two (2) weeks of the acceptance of his tender to Main Contract and to the Architect for approval.

The works are associated with supply and installation of electrical systems, transport to site, offloading, labour installation, fixing, connecting, commissioning and delivering up clean and in working order in every detail.

D SANITATION OF THE WORKS

The sanitation of the Sub-Contract Works shall be maintained by the Sub-Contractor to the satisfaction of the Government and/or Local Authorities, Labour Department and the Architect.

Carried to Collection USD.

A ATTENDANCE BY MAIN CONTRACTOR

The Main Contractor shall be responsible for Nominated Subcontractors in every respect and in particular it shall be the Main Contractor's responsibility to ensure that each Sub-Contractor commences and completes the work in such a manner and is ready on the site with his materials, labour and special plant at such time so as to conform with the completion programme, as previously specified, and to ensure satisfactory progress.

The Main Contractor shall accept liability for and bear the cost of General and Specific Attendance on Nominated Sub-Contractors which shall be deemed to include for:

- Allowing the use of standing scaffolding, retention of all scaffolding until such time as all relevant Sub-Contract works are complete and removal of all scaffolding on completion.

- Providing of space for office accommodation, and for storage of plant and materials; use of sanitary accommodation; the supply of all necessary water, and lighting; and clearing away all rubbish with reasonable assistance from the Nominated Sub-Contractor.

The Main Contractor shall also accept liability for and bear the cost of Special Attendance of Nominated Sub-Contractors which shall include for one or more of the following:

- Unloading, storing, hoisting, and placing in position, providing power, provision of special scaffolding.

- Cutting away for and making good after the work as may be required will be measured and valued separately by the Quantity Surveyor.

Carried to Collection USD.

B PAYMENTS

The Nominated Sub-Contractor will be entitled to payment from time to time for materials and/or any work carried out under this Sub-Contract, the value of which shall be determined by the Consultant Engineer and included in Payment Certificate to the Main Contractor under the Main Contract. The Nominated Sub-Contractor will be informed by the Quantity Surveyor when such payments are certified and should he not receive from the Main Contractor the payment due within the period stipulated in the Conditions of Sub-Contract he should immediately report to the Architect and the Engineer.

C MATERIALS ON SITE

Unless otherwise agreed by the Architect all materials relating to this Sub-Contract must be delivered to the site before payment for such items may be certified.

Carried to Collection USD.

A RETENTION

Ten Percent (10%) of the value of work done will be held as retention in the valuation for each Interim Payment for this Sub-Contract. The first moiety of five percent (5%) retention money will be released on practical completion of the Sub-Contract works and the second moiety will be released on satisfactory completion of the maintenance works at the end of the six months Defects Liability Period.

B LIQUIDATED & ASCERTAINED DAMAGES

If the Nominated Sub-Contractor fails to complete the works tendered for or any section of it within the agreed period of completion or within any extension period granted by the Architect, he will be required to allow or pay to the Main Contractor a sum equivalent to any loss or damages suffered or incurred to the Main Contractor caused by or resulting from such failure.

C DEFECTS

The Nominated Sub-Contractor shall be liable to make good at his own cost all defects or other faults occurring in the Sub-Contract works within a period of six months from date completion as defined herein and shall bear any expenses reasonably incurred by the Main Contractor as a direct consequence of such defects. Provided that such defects have not been caused as a result of defective workmanship or material for which the Main Contractor is responsible. Any work or section of the Sub-Contract works which are badly affected by such defects, etc and in the opinion of the Architect cannot be satisfactorily made good by repairs, etc shall be carried out again by the Nominated Sub-Contractor at his own cost within a reasonable time of being required to do so in writing by the Architect or the Main Contractor.

Carried to Collection USD.

A **UNAVOIDABLE DELAYS IN IMPORTED MATERIALS**

During the progress of the works where delays are anticipated in obtaining imported materials or locally manufactured materials requiring imported components, the Architect should be informed in writing as early as possible. An application for extension(s) of time must also be made in writing at the same time. Where the accepted Sub-Contractor can fully substantiate with documentary evidence that every effort has been made and the correct procedures followed for obtaining the materials or where applicable the import licences and the delays are unavoidable, the Architect will, if satisfied, grant such extension(s) of time. Liquidated and ascertained Damages shall then not be imposed for such delays. The successful Sub-Contractor shall, however be expected to place appropriate orders for all imported and locally manufactured materials immediately after the signing of the Sub-Contract Agreement in order to minimise the risk of delays caused through shortages of materials. The Tenderer should state below in the space provided any materials which in his opinion it is anticipated may be in short supply and likely to cause such delays.

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Carried to Collection USD.

A PURCHASE OF BUILDING MATERIALS IN ADVANCE

The Sub-Contractor will be required, immediately after the signing of the Sub-Contract to purchase in advance as much as possible of the building material requirements of the Sub-Contract in order to avoid possible future price increase and shortages. To qualify for inclusion in interim payment certificates all such materials shall be suitably stored on site or in an approved bonded warehouse adequately insured against theft and damage for the period of the storage, all to the approval of the Architect. Where any material is not immediately available the appropriate orders must be placed as soon as possible after the signing of the Sub-Contract and all appropriate measures must be taken to secure early delivery of such materials.

B SITE MEETINGS

The Nominated Sub-Contractor or his authorised representative shall attend site meetings whenever the Architect requires and the Tender Price will be deemed to include for all expenses in connection with such visits.

C DAMAGE TO SUB-CONTRACT WORKS, ETC.

The Nominated Sub-Contractor shall take every precaution to prevent damage to all existing property on site including the Main Contract Works and will be responsible for and shall pay for the making good of any such damage to the satisfaction of the Architect.

D SECURITY

Maximum precautions must be exercised to uphold existing security in the vicinity of the Works. The Sub-Contractor shall comply with all instructions issued by the Employer, Architect or the Main Contractor with regard to the upholding of security arrangements and will be held responsible for any breach of security by his own, his suppliers' or others' employees engaged directly or indirectly on the Sub-Contract Works.

Carried to Collection USD.

A "OUT OF BOUNDS" AREAS

The movement of the Sub-Contractor's men must be confined strictly to the works and the Sub-Contractor's working and Storage Areas. Certain areas within and adjacent to the site and to be identified later, will be designated "Out of Bounds" areas for the Sub-Contractor's employees and the Sub-Contractor will be required to comply strictly with this rule.

B WORKING AND STORAGE SPACE

The Sub-Contractor shall provide at his own risk and cost safe storage and custody of materials for the Works. Working and storage space for the Sub-Contractor's materials plant and workmen will be allotted by the Main Contractor within the limits of the area made available to him for this purpose. All activities pertaining to the works will be confined as far as is possible to the specified area or areas. No such activities will be carried out outside the area(s) without the specific authority of the Architect. The allotted area is located within an existing building and the Sub-Contractor will be required to erect temporary barricades to the approval of the Architect and clear them away when no longer required. No materials shall be stored or stacked on suspended slabs without prior approval of the Architect.

Carried to Collection USD.

A GOVERNMENT ACTS REGARDING WORK PEOPLE, ETC.

Allow for complying with all Government Acts, Orders and Regulations in connection with the employment of labour and other matters related to the execution of the works. In particular, the Sub-Contractor's attention is drawn to the provisions of the Factories Act Revised Edition 1972, and his tender must include for all costs arising or resulting from compliance with any Act, Order or Regulation relating to Insurance's, Pensions and Holidays for work people or to the safety, health or welfare of work people. The Sub-Contractor must make himself fully acquainted with current Acts and Regulations, including Police Regulations regarding the movement, housing, security and control of labour camps, passes for transport, etc. It is most essential that the Sub-Contractor, before tendering, shall obtain from the relevant Authority the fullest information regarding all such regulations and/or restrictions which may affect the organisation of the works, supply and control of labour, etc. and allow accordingly in his tender. No claim in respect of want of knowledge in this connection will be entertained.

Particular attention is drawn to the Rules published in Legal Notice 179, dated 2nd June 1979. (Building Operations and Works of Architecting Construction).

B SAMPLES

The Sub-Contractor shall furnish at his own cost any sample of materials or workmanship required by the Architect / the Engineer for his approval or rejection and any further samples in the case of rejection until such samples are approved by the Architect / Engineer. The Architect / Engineer may reject any materials or workmanship not in his opinion up to approved samples. The Architect / Engineer shall arrange for the testing of such materials as he may at his discretion deem desirable. The testing shall be made at the expense of the Sub-Contractor. The procedure for submitting samples of materials for testing and the method of marking for identification shall be as laid down by the Architect. The Sub-Contractor shall allow in his tender for all such samples and tests.

Carried to Collection USD.

A INSURANCE

The Sub-Contractor shall during the execution of the works insure himself and keep himself insured against all liability arising under the Workmen's Compensation Act or any amendment thereto for accidents to workmen employed by him on the said Works and shall indemnify the Employer in respect of any such accident to any such workmen. The Sub-Contractor shall further insure himself and keep himself insured against all liability arising from all Third Party Claims arising from accidents and he shall indemnify the Employer in respect of all claims, which may be made against him in respect of any such accidents. No payment on account of the work executed will be made to the Sub-Contractor until he has satisfied the Architect either by the production of an Insurance Policy or an Insurance Certificate that the foregoing provisions have been complied with in all respects. Thereafter the Architect shall from time to time ascertain that premiums are duly paid up by the Sub-Contractor who shall if called upon to do so, produce receipted premium renewals for the Architect's inspection.

B METHOD OF MEASUREMENT

These Bills of Quantities have been prepared in accordance with the principles of the "Standard Method of Measurement of Building Works for East Africa", unless otherwise expressly stated.

A MANUFACTURERS' OR PROPRIETARY NAMES

Where Manufacturer's or Proprietary names or catalogues number are mentioned in these Bills of Quantities the reference is intended as a guide to the type of article or quality of material required. The Sub-Contractor may use any article or material equal in type or quality to those herein described subject to the prior approval of the Engineer and at his absolute discretion. The onus of proof as to equivalent quality will rest with the Sub-Contractor, whose tender will be deemed to include for the makes described in the Bills of Quantities.

Carried to Collection USD.

A CLAIMS FOR EXTRAS

The Sub-Contractor shall submit to the Architect and Contractor claims for any work or circumstances on account of which he may consider that he is entitled to extra payment within seven days from the time of the commencement of such work or occurrence of such circumstances. Any such claim must be in writing and accompanied by full particulars and must state under which provision of the Sub-Contract it is claimed so that payment shall be made.

B PRIME COST AND PROVISIONAL SUMS

The terms "Provisional Sum" and "Prime Cost Sum" or "P.C. Sum" wherever used in these Bills of Quantities shall be deemed to have the same meaning as defined in the General Preliminaries to the Main Contract Bills. The adjustment of these Sums shall similarly be dealt as described in the above General Preliminaries.

C LABOUR CAMPS

The Sub-Contractor will be permitted to house labour on the site and must make his own arrangements to construct the houses. Cooking and eating facilities for workers will be permitted on the site.

D WORKING AND RECORD DRAWINGS

The Sub-Contractor shall prepare all necessary sets of schematic diagrams, working drawings, etc required by the Engineer and shall also prepare and provide sets of Records Drawings together with instruction charts, maintenance manuals, etc all as specified in the attached General Specification.

Carried to Collection USD.

A **FIRM PRICE SUB-CONTRACT**

Unless otherwise specifically stated in the Preliminaries, this is a Firm Price Sub-Contract and the Sub-Contractor must allow in his tender for any increase in cost of labour and/or materials during the currency of the Sub-Contract. No claim for increased costs will be entertained except for increased costs, which may arise from fluctuations in Duties, and Exchange Rates defined in Clause 32 of the Sub-Contract Agreement.

B **WATER AND ELECTRICITY FOR THE WORKS**

These will be made available by the Main Contractor but the Sub-Contractor will be liable for the cost of any water or electric current used and any installations provided especially for his use.

C **PROVISIONAL WORK**

Quantities given as "Provisional" in these Bills of Quantities shall not be held to gauge or limit the amount or description of the work to be executed by the Sub-Contractor. However, the value thereof shall be deducted from the Sub-Contract Sum and the value of the work ordered by the Architect and executed thereunder shall be ascertained as provided by the relevant Clause of the Conditions of Sub-Contract. All "Provisional" and other work liable to adjustment under this Sub-Contract shall be left uncovered for a reasonable time to allow measurements needed for such adjustment to be taken by the Engineer and Quantity Surveyor. Immediately the work is ready for measuring, the Sub-Contractor shall give notice to the Architect. If the Sub-Contractor makes default in these respects, he shall, if the Architect so directs, uncover the work to enable measurements to be taken and afterwards reinstate all at his own expense.

D **CASING UP, PROTECTING AND HOARDING**

The Sub-Contractor shall be responsible for casing up, protecting or otherwise to the satisfaction of the Architect all parts of the Sub-Contract Works liable to damage or to cause injury and for removing such protection and making good at completion of the Works. The Sub-Contractor shall take into account that the works shall be carried out concurrently with other trade works and the safety of staff shall remain the responsibility of the Sub-Contractor during the course of the Sub-Contract.

E **WORKS TO BE DELIVERED UP CLEAN**

On completion of the Works, the Site and the Works shall be cleared of all plant, scaffolding, rubbish and unused materials and shall be delivered up in a clean and perfect condition in every respect to the satisfaction of the Architect.

Carried to Collection USD.

B ADDITIONAL ITEMS

Any additional item(s) which the Tenderer may wish to price separately and which he considers has not been included in the foregoing Conditions, Specification and/or Bills of Quantities.

Description_____

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C EXISTING INSTALLATIONS

All items, which have been disconnected and removed from the existing installations in accordance with the Technical Specifications, shall remain the property of the Employer. These items shall be packaged in waterproof boxes and kept in storage as directed by the Employer. The Employer may however opt to surrender the same to the Sub-Contractor at a salvage value, which shall mutually be agreed between the Employer and The Sub-Contractor.

Carried to Collection USD.

SECTION 2

PRELIMINARIES COLLECTION

ITEM	AMOUNT (USD)
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PART 2:
GENERAL REQUIREMENTS
KISII CANCER CENTRE - KISII COUNTY, KENYA

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EQUIPMENT AND MATERIALS INCLUDED IN THE TENDERED SUM

2 GENERAL REQUIREMENTS

2.1 DESCRIPTION OF THE MAIN CONTRACT WORKS

The Proposed Kisii cancer centre is located in Kisii County..

The project shall include infrastructure and civil works.

The Air Conditioning and Mechanical Ventilation Systems shall be carried out to Health Technical Memorandum (HTM) 03, local and international standards to provide systems that are operational, efficient, optimal, buildable, maintainable and cost effective. The services included in this tender package include:

a) Mechanical Ventilation comprising of:
- Air Handling Units;
- Air distribution ductwork;
- Air terminal points, transfer grilles and pressure control dampers;
- Laminar floor diffusers;
- Exhaust fans;
- Exhaust hoods etc.

b) Air – Conditioning systems shall entail:
- Temperature control;
- Humidity control;

Drawings of the development may be inspected at the offices of the Architect and the Engineer provided this is done by appointment.

The services drawings are provided with the Specification - as per the Schedule of Drawings.

The above sub-contract works shall be carried out by a nominated sub-contractor and as such will be required to work in close liaison with the main contractor and all other sub-contractors. It is essential that complete co-ordination is maintained at all times to enable the timely completion, within the specified contract periods, of the Works. The sub-contractors will be required to agree with the main contractor the full working programme for all elements of the contract. Certain areas are more critical to the completion than others as certain items of plant and equipment, which will be required to be installed and commissioned, may experience long delivery dates. The specialised sub-contractors must identify these areas and agree on dates for completion with the main contractor and the Engineer so that no delays to the main contractor and other specialists are caused.

This section of the contract relates to the Air Conditioning and Mechanical Ventilation.

2.2 SCOPE OF THE WORKS

The works to be carried out under this section of the contract shall include Air Conditioning and Mechanical Ventilation including all the necessary pipework and ductwork. These items, together with other contract requirements, have been further expanded under later sections of the Specification.

(i) Design;
(ii) Manufacture;
(iii) Supply;
(iv) Delivery to site;
(v) Installation;

(vi) Works testing;
(vii) Commissioning;
(viii) Performance testing;
(ix) Making good any defects that occur during the defect liability period;
(x) Provision of 'As Installed' drawings and Maintenance and Operation documents;
(xi) The whole of the labour and all materials necessary to form a complete installation (whether or not all the necessary components are indicated).

The sub-contractor shall supply all labour, materials, plant, equipment and components necessary and execute the services installations described above and set out in this section of the Specifications, Bills of Quantities and the accompanying Drawings and in accordance with the general specifications herewith.

Unless otherwise indicated within this Specification, all equipment and materials to be installed shall be new and the Contractor shall ensure that all equipment can be installed in the allotted spaces and maintain adequate access for maintenance and repair. All equipment shall be installed in accordance with the manufacturers written instructions.

2.3 EXTENT OF SUB-CONTRACT

The sub-contract shall include, in addition to all items scheduled above, for the design, manufacture, inspection and testing, packing for shipment, insurance, shipping, delivery to site, unloading and all other charges, complete erection, tests on completion, setting to work, finishing, painting and maintenance for a period of twelve calendar months, all to the satisfaction of the Architect and Engineer, of the items of Plant and Equipment described or implied within this Specification and shown on the relevant Drawings. **The sub-contract works shall be exempt from all taxes as imposed by Kenya Revenue Authority.**

The proposed installations within the new facilities are required to be complete in all respects as specified herein, and shall include all items of equipment, materials, accessories, fittings, supports, etc. necessary whether such items are specifically referred to in the contract or not. The sub-contractor shall be deemed to have included in his tender price for all items necessary such that the installations are complete in all respects and left in a satisfactory working order.

The sub-contractor shall provide fully detailed drawings of the entire installation together with layouts of all civil and building works etc. required to accommodate/house the plant and equipment, these layout drawings and details being related to the existing layouts as may be necessary. The drawings shall be submitted for approval within three weeks of the award of the sub-contract such that the Architect and Engineer can be made aware of all requirements. It shall be fully the responsibility of the sub-contractor to liaise with the main Contractor to ensure all civil and builder's works required for this sub-contract are prepared and/or provided to suit the programme of this contract. No claims will be entertained.

All modifications to existing layouts and all proposed new layouts and structures shall be subject to the full approval of the Architect, Engineer and the Employer.

2.4 SUB-CONTRACT PERIOD AND PROGRAMME

The sub-contractor shall provide within the stipulated period after the acceptance of his Tender, a complete programme for the execution of this contract. This programme shall indicate the expected dates of the commencement and completion of the following specialist contract works: -

(i) Submission of Working Drawings for approval;
(ii) Placing of orders with other specialists or sub-contractors for Plant and Equipment to be incorporated in the Works;
(iii) Receipt by the sub-contractor from other specialist or sub-contractor's of Plant to be incorporated in the Works;
(iv) Manufacture by the sub-contractor of Plant to be incorporated in the Works;

(v) Inspection and testing by the Engineer;
(vi) Shipment from country of supply;
(vii) Delivery to Site;
(viii) Erection on Site, details for all activities;
(ix) Tests on Completion. Operations shall be commenced when instructed and shall be carried forward to completion with the greatest possible expediency, to the satisfaction of the Architect, and Engineer, in accordance with the Programme. The sub-contractors programme shall be agreed with the main contractor, as the sub-contractor shall adhere fully to the requirements and timing of the agreed main contractors programme.

2.5 DRAWINGS ACCOMPANYING THE TENDER DOCUMENTS

Drawings accompanying this Specification indicate generally the arrangement of the installations and are for assistance in tendering. The position of equipment and apparatus shown thereon are approximate only, the exact positions, together with the actual runs of ductwork, trunking and conduit etc., will be agreed with the Architect, the Engineer and the Employer before commencement of work. It shall be deemed that the prices entered by the sub-contractor include for the repositioning, of the various services, to meet the above requirements. No claims will be entertained.

The sub-contractor shall satisfy himself as to correctness of all Drawings and measurements particularly the dimensions of the works already constructed on site. If the sub-contractor finds any discrepancy in the Drawings or between the Drawings and the Specification or between the constructed works and the Drawings he shall immediately refer the same to the Architect and Engineer who will decide which shall be followed. Figured dimensions shall be taken in preference to the scale mentioned on or attached to any Drawings. Details shown on Drawings shall be read in conjunction with items in the Specification.

Copies of all Drawings and of the Specification will be furnished free of cost to the sub-contractor for his own use.

The Architect will furnish to the sub-contractor within a reasonable time after the receipt by the Architect of a written request for the same, any details which, in the opinion of the Architect are necessary for the execution of any part of the work such request to be made only within a reasonable time before it is necessary to execute such work in order to fulfil the contract. One copy of the Drawings, details and Specification shall be kept on the site until the completion of the sub-contract and the Architect shall at all reasonable times have access to the same. All copies of Drawings and details shall be returned by the sub-contractor to the Architect on the completion of the Contract.

Additional Drawings will be issued by the Engineer to suit the design requirements of the works these Drawings being issued either during or after the tender period as may be required or necessary. These drawings will supplement the details contained within the Specification and Bills of Quantities and the tenderer shall be deemed to have taken these into account in his pricing. Where the sub-contractor can demonstrate that the Drawings relate to new or additional items these new or additional items shall be priced to approval and shall be in accordance with the sub-contract rates and prices.

2.6 SUB-CONTRACT WORKING DRAWINGS

The sub-contractor shall prepare fully detailed Working Drawings for all items of plant, equipment and accessories required for installation under this section of the contract. Two copies of each Drawing shall be forwarded to the Engineer for approval and or comments. One copy will be returned stamped "approved" or "not-approved". Where Drawings require further information and/or modifications to meet the comments made by the Engineer they shall be re-submitted, again in duplicate, for approval.

When Drawings have been approved two further copies shall be forwarded to the Engineer, together with copies to the Architect, site and the Employer.
Drawings, and, where relevant, calculations in respect of the following shall be prepared by the sub-contractor and submitted to the Engineer for his approval commencing within ten (10) days from acceptance of the tender.

All drawings shall be to scale and fully detailed and all-important dimensions shall be given and the material of which each part is to be constructed shall be indicated.
During progress of the building works, the sub-contractor shall make all necessary checks on site to make certain the various Services can be installed as specified and shown on the approved Drawings.

Where such works cannot be so installed, this must be immediately brought to the notice of the Architect and Engineer prior to the progress of such works.

The Engineer, in conjunction with the Architect and the Employer, will check and return the Drawings submitted for approval within a reasonable period, not exceeding fourteen (14) days from receipt.

The layouts of plant and equipment are for general guidance only. The sub-contractor shall assess the requirements immediately and prepare a plant layout for approval, the required liaison being maintained with other specialists, sub-contractors and main contractor such that an agreed layout is submitted for approval.

2.7 RECORD DRAWINGS

As soon as the works are complete and all tests have been satisfactorily carried out, the sub-contractor shall hand to Architect/Engineer two sets of Record Drawings, together with one set of negatives of these record drawings, showing the works as finally installed. These drawings shall be prepared on approved transparent plastic material in black ink or as approved by the Architect/Engineer. The certificate, of making good defects, will not be issued until this condition has been complied with. Record Drawings are in addition to detailed Working Drawings and shall show all cable routes, circuits, trunking, conduits, plant, trenches, ductwork and ducts etc., together with the entire Air Conditioning and Mechanical Ventilation as finally installed.

The Architect will provide the sub-contractor with a set of Contract Drawings (in addition to the two sets provided for the sub-contractor's site and office use), which shall be maintained by the sub-contractor's representative on site and which shall be used for recording contract variations as they occur. This set of Drawings shall be available for the Architect's inspection on site, and shall be kept up to date.

The cost of the preparation and submission of the above Contract and Record Drawings shall be deemed to be included within the sub-contractor's prices.

2.8 MAINTENANCE MANUALS

Upon Practical Completion of the Contract Works, the Contractor shall furnish the Engineer four copies of a Maintenance Manual relating to the installation forming part of all of the Contract Works.

The manual shall be loose-leaf type, International A4 size with stiff covers and cloth bound. It may be in several volumes and shall be sub-divided into sections, each section covering one Engineering service system. It shall have a ready means of reference and a detailed index.

There shall be a separate volume dealing with Air Conditioning and Mechanical Ventilation installation where such installations are included in the Contract Works.

The manual shall contain full operating and maintenance instructions for each item of equipment, plant and apparatus set out in a form dealing systematically with each system. It shall include as may be applicable to the Contract Works the following and any other items listed in the text of the Specifications:

System Description shall include but not limited to:

1) Plant;
2) Valve Operation;
3) Switch Operation;

4) Procedure of Fault Finding;
5) Emergency Procedures;
6) Lubrication Requirements;
7) Maintenance and Servicing Periods and Procedures;
8) Colour Coding Legend for all Services;
9) Schematic and Writing Diagrams of Plant and Apparatus;
10) Record Drawings, true to scale, folded to International A4 size;
11) Lists of Primary and Secondary Spares.

The manual is to be specially prepared for the Contract Works and manufacturer's standard descriptive literature and plant operating instruction cards will not be accepted for inclusion unless exceptionally approved by the Engineer. The Contractor shall, however, affix such cards, if suitable, adjacent to plant and apparatus. One spare set of all such cards shall be furnished to the Engineer.

2.9 BUILDER'S WORK AND CIVIL WORKS

All Builder's Work and Civil Works incidental to this section of the contract such as the cutting of holes in walls and floors, the provision of foundations for plant and machinery, the building in of lifting beams, breaking into the existing plant rooms and duct systems, changes in levels the protection of existing structures, painting and the re-instatement of the plant rooms and associated areas to their original standard etc shall be the responsibility of the main contractor. The sub-contractor shall however be fully responsible for the preparation of all such details that relate to this sub-contract works, the details being subject to approval by the Architect and Engineer prior to submission to the main Contractor for action. Other items such as the fixing of brackets, cable and ductwork ducts and trenching, making good, etc shall be carried out by the sub-contractor to suit the installation of all the services.

It is the sub-contractor's sole responsibility to ensure that all holes and chases etc are in the required position and that any additional ducts, holes and chases necessary for the erection of the installations in situ concrete walls, floor slabs etc., are included in the early stages of construction as appropriate.
The sub-contractor shall furnish the Architect, Engineer and main Contractor with all information as to where foundations, brackets and fixings are required and shall ensure that such work is done in accordance with such information.

The sub-contractor shall include in his tender for all supports, fixings, the plugging of all walls, ceilings and floors to facilitate the fixing of the pipework, accessories, and all other portions of the Air Conditioning and Mechanical Ventilation installations. Any purpose made fixing brackets shall also be provided and installed by the sub-contractor, including escutcheon plates and the like.

The sub-contractor is to set out at the earliest opportunity the position of all holes necessary for the passage of ducts, pipe-work and conduits or otherwise required in connection with his work, and should additional holes or openings be required due to failure of the sub-contractor to fulfil the conditions of this clause, then he must arrange for the main Contractor to make such openings, etc at his own expense. The sub-contractor is not to arrange for the cutting of any holes or openings unless specifically authorised to do so and should he do so without approval, he will become liable for any damage to the building or fittings.

The sub-contractor shall supply and install approved pipework support brackets and hangers. It shall be deemed that the prices entered include for any special requirements and that the sub-contractor has visited the site during the tender period to ascertain all details.

The sub-contractor shall pay particular attention to the fixing and alignment of items. All items shall be installed square, true and perpendicular to floors i.e. as shown on Drawings and as may be required at site to the Engineers approval and to suit the existing and new services.

2.10 GUARANTEE

The sub-contractor shall guarantee all work for a period of twelve months after acceptance by the Architect. In the event of a defect arising within the contract defects liability period which, in the opinion of the Architect, is due to faulty workmanship or materials, the sub-contractor shall, at his own expense, make good such defects where instructed to do so, to the satisfaction of the Architect.

2.11 SETTING TO WORK

The sub-contractor shall instruct the Employer's Maintenance Engineer or his representative on the operation and maintenance of the various components forming the Air Conditioning and Mechanical Ventilation installations and shall provide such drawings, diagrams and manuals to ensure the Maintenance Engineer or his representative is completely conversant with such installations.

The sub-contractor shall ensure that the Services Installations are left in complete safe working order and operating to the satisfaction of the Architect and the Engineer.

2.12 REGULATIONS AND STANDARDS

The Installations must be carried out strictly in accordance with the following documents: -

Electrical Services

(i) The current edition of the 'Regulations for the Electrical Equipment of Buildings' issued by the Institute of Electrical Engineers of Great Britain;
(ii) Electrical Supply Authority;
(iii) Relevant British Standard Specifications and Codes of Practice published by the British Institution (hereinafter referred to as B.S. and C.P. respectively);
(iv) Regulations of the Government of Kenya;
(v) Water Supply and Sewerage Authorities Regulations;
(vi) Any other duly constituted authorities regulations having jurisdiction over the works;
(vii) The Specification and accompanying documentation and Drawings;
(viii) The Working Drawings, produced by the sub-contractor and approved by the Architect/Engineer.

Mechanical Installations

(i) The Kenya Bureau of Standards;
(ii) Relevant British Standard Specifications and Codes of Practice published by the British Standard Institution (hereinafter referred to as B.S. and C.P. respectively);
(iii) Regulations of the Government of Kenya;
(iv) Water Supply and Sewerage Authorities Regulations;
(v) Any other duly constituted authorities regulations having jurisdiction over the works;
(vi) The Specification and accompanying documentation and Drawings;
(vii) The Working Drawings, produced by the sub-contractor and approved by the Architect/Engineer;
(viii) The Loss Prevention Council Regulations.

The sub-contractor shall undertake all modifications demanded by the authorities in order to comply with the regulations, and produce all certificates, if any, for the authorities without extra charge.

2.13 QUALITY OF MATERIALS

All materials, fittings and accessories are to be new and in accordance with the requirements of the current rules and regulations where such exist, and with the relevant British Standard Specification.

Uniformity of type and manufacture of fittings or accessories is to be preserved as far as practicable throughout the whole work.
Wherever in this specification the practice is adopted of specifying a particular item as 'similar' to that

listed in a particular firm's catalogue, it is to be clearly understood that this is to indicate the type and quality of the equipment required. No attempt is being made to give preference to the equipment supplied by the firm whose catalogue is quoted.

Where particular manufacturers only are specified herein no alternative makes will be considered without good reasons.

All materials shall be good quality, suitable for the purpose specified, and to the approval of the Architect and Engineer.

2.14 WORKMANSHIP

The sub-contractor shall take into consideration, when pricing his tender, that there will be other sub-contractors working. Any disruptions to the existing services must therefore be kept to an absolute minimum, and in this respect the sub-contractor shall include in his prices for carrying out works outside normal operating hours as may be directed by the Architect or Engineer. No claim will be entertained where abnormal working hours are required to meet this requirement and completion of the works within the specified contract period.

The sub-contractor shall be fully responsible for the co-ordination of all services, both new and existing, and in this respect he shall ascertain that the installation of the services will not foul other new or existing services. In all cases services through ducts etc. must be readily accessible for maintenance.

The sub-contractor shall be deemed to have included in his tender prices for locating switches, terminal points, ductwork, outlets and fixtures in positions and/or locations at least one metre, both horizontally and vertically from those positions indicated on the contract drawings. Within these limits no variations in the sub-contract sum will be made unless the work has already been executed in accordance with previously approved Working Drawings.

All trade work shall be carried out by tradesmen fully competent and qualified in their respective trades, and the entire installation shall be performed in a neat and workmanlike manner.

The sub-contractor shall take every precaution to avoid damage to all existing property including roads, paved walkways, grassed areas, landscaping, cables, drains and other services, and he will be held responsible for and shall make good all such damage arising at his own expense to the satisfaction of the Architect.

The sub-contractor will be responsible for the exact runs and placing of pipework, conduit, boxes, ductwork and accessories that are to be cast in concrete ceilings, floors, walls, columns and beams, and for the proper fixing of the pipework and accessories to the shuttering and the steel reinforcement work.

Where ductwork is to concealed, the pipes etc shall be in an exact position relative to the finished plaster or such other finishes as may be applied to enable adequate cover to be applied.

Where services are run above the false ceilings the sub-contractor shall ensure that access to all services is readily available such that future maintenance can be carried out without difficulty. Full details shall be included on the Working Drawings such that the Architect and Engineer can give consideration to the sub-contractor's proposals.

2.15 LAYING OUT OF WORK

The sub-contractor will be responsible for laying out his work and shall obtain all necessary information as may be required to carry out the work, and such information shall be obtained sufficiently in advance to avoid any possibility of delay to the works as a whole.

The sub-contractor shall be fully responsible, and shall inform himself of, the details of all work being carried out by the various trades on Site, particularly where such trades may interfere one with the other,

or where co-ordination is necessary. No claims for extra costs will be met arising from omissions, oversights, or neglect in this regard.

The sub-contractor shall arrange for the supply, in advance of the delivery of the equipment, of all necessary foundation bolts, templates, nuts, plates, sleeves, anchorage, etc., as required and as may be directed by the Engineer or Architect.

2.16 ERECTION AND CHECKING OF WORK

The sub-contractor shall provide, and be solely responsible for, all skilled and unskilled labour, tools, lifting tackle and other equipment required for transport to the site, the handling and transport about the site and the erection of the plant and equipment.

As each part of the Works is erected, it shall be subject to approval by the Engineer.

All parts shall pass such tests on the site as required by the Architect and Engineer to prove compliance with the contract irrespective of any tests which may already have been carried out at the Manufacturer's Works. In particular all electrical pressure tests made at the Manufacturer's Works shall be repeated at voltages approved by the Engineer.

The sub-contractor shall supply and install all supports, fixings, brackets and similar items as may be necessary for the completion of the installation of the services as specified and as shown on the Drawings.

2.17 PERFORMANCE AND ACCEPTANCE TESTS ON SITE

The sub-contractor shall give to the Engineer in writing at least five days notice of the date after which he will be ready to make the specified tests on completion of installation. Unless otherwise agreed the tests shall take place within seven days after the said date on such day or days as the Engineer shall in writing notify the sub-contractor. The tests shall be carried out under normal working conditions to the satisfaction of the Engineer and shall extend over such continuous periods as he may direct.
All skilled labour, supervision, apparatus, fuel for tests and instruments required for carrying out the tests efficiently will be the responsibility and at the expense of the sub-contractor. The accuracy of the instruments shall be demonstrated if required.

If any part of the plant or equipment fails to pass the specified tests, further tests of the said part shall, if required by the Engineer, be repeated. The sub-contractor shall, without delay, put in hand such modifications as are necessary to meet the requirements as described in the Contract and any expense which the Employer may have incurred by reason of such further tests shall be deducted from the sub-contract price.

Each completed system within the installation shall be tested as a whole under operating conditions to ensure that each component functions correctly in conjunction with the rest of the system.

2.18 TEST RECORDS

The sub-contractor shall make all necessary records of the tests carried out, and when the tests have been successfully completed he shall provide the Architect and Engineer with test records and reports in a form to be agreed.

The Air Conditioning and Mechanical Ventilation be deemed to be complete when the following obligations have been fulfilled by the sub-contractor: -

(a) The satisfactory completion of the Performance and Acceptance Tests on Site;

(b) Test records and reports have been received;
(c) The handing over of two preliminary sets of Record Drawings. The supply of these preliminary

Record Drawings shall not relieve the sub-contractor of his obligations to supply Record Drawings in accordance with the requirements of the Specification;

(d) The issue of an acceptance certificate by the City Council for all works associated with the Air Conditioning and Mechanical Ventilation systems as may be necessary and required;

2.19 DUST, INSECT AND VERMIN PROOFING

All equipment, which is affected by ingress of dust, shall be effectively dust proofed and also vermin proofed where no protection is afforded in its normal manufactured form. All materials used shall be in general resistant to attack by insects, microbiological life or other local fauna and such materials shall be to the approval of the Architect and Engineer.

2.20 PAINTING AND FINISHING

All mechanical and electrical equipment installed under this sub-contract shall be painted or otherwise finished to approval in accordance with B.S. Code for Standard Colours including all pipework and ductwork, etc. Such finish shall be entirely compatible with the conditions of heat, humidity, exposure to the weather, and other relevant factors arising from the materials, location and condition of operation of the equipment.

The Architect may request examples of paint finishes, the cost of which shall be deemed to have been included within the tendered prices for all works.

All final painting of equipment, fixtures, and accessories shall be carried out by the sub-contractor, except where it is the usual practice of the manufacturer of items of plant, equipment, and switchgear etc to apply a high standard of protective finishing paintwork in the shop before despatch. This will be acceptable provided any damage to paintwork that occurs before the plant is taken over is made good by the sub-contractor at his own costs.

The interiors of electrical switchboards, control panels, and similar items, where supplied by the sub-contractor shall be finished in approved enamel and shall comply with the appropriate B.S. for enamel finish. The exteriors of such panels and enclosures shall be of British Standard Specification colour as specified by the Architect.

2.21 LABELS

All items of plant, valves, tee's etc shall be neatly and clearly labelled externally with identification marks corresponding with those on Drawings or in Specifications. Final details shall be agreed.

Identification labels shall be of laminated plastic material engraved, black on white, with no less than 6mm "Lino" style letters and shall be fixed on or adjacent to all items by means of at least two brass screws or to approval.
All main switches, circuit breakers, isolators, valves, motors, switch-fuse, consumer's service units, and distribution boards etc shall be neatly and clearly labelled externally with identification marks corresponding with those on Drawings or in Specifications. Final details shall be agreed with the Engineer, but all labels/plates shall be in English.

2.22 SPARE PARTS AND SPECIAL TOOLS

The sub-contractor shall submit his recommended list of spares covering a period of two years for all plant and auxiliary equipment supplied under this sub-contract. This list shall be priced individually, but not carried forward to the Bills of Quantities where provisional sums have been included for the purchase of spare parts. Before a Taking-Over Certificate is issued a full set of spares as agreed shall be handed over to the Engineer.

Complete sets of any special tools, necessary for the operation, maintenance and dismantling of various sections of the plant and equipment shall be provided in a strong box or boxes each fitted with a suitable padlock and two keys. Such tools shall not be used by the sub-contractor during the erection of the plant or equipment. The cost of these tools shall not be carried forward to the Bills of Quantities where a provisional sum has been included for the purchase of these special tools.

2.23 SPECIALIST MANUFACTURERS AND SUB-CONTRACTORS

Where specialists are not nominated by the Employer, the sub-contractor shall appoint specialist manufacturers and contractors for any sections of the Works described herein in which he is not himself an experienced, recognised and approved operator.

The Tenderer shall, on submission of his Tender, indicate the names of all proposed specialist manufacturers and contractors, together with the precise sections of the Works for which each will be responsible. The sub-contractor may be required to seek alternative manufacturers or contractors or to accept specialists nominated by the Employer. It shall be deemed that the prices entered include for this requirement.

The sub-contractor shall allow in his prices for phasing his work to meet the requirements of the other sub-contractors and any specialists, and for varying his programme or otherwise, to comply with the erection programme of such specialist or sub-contractors. No additional costs will be allowed to the sub-contractor for any disruptions to his programme, or otherwise, in his compliance with the above requirements.

2.24 USE OF SITE

The lands and other places outside the Site that are the property of or under the control of the Employer shall not be used except with the approval of the Architect or Engineer.

The sub-contractor shall at any time remove any vehicle, wagon, or any other obstruction within his control that may be required to be moved by the Architect/Engineer for any purpose and the sub-contractor shall move such obstruction promptly on instruction being given and at his own cost, unless the Architect/Engineer shall decide otherwise.

The sub-contractor shall maintain access for the inspection, operation and maintenance of any of the Employer's plant or work that lies within the Site or elsewhere. The sub-contractor shall not use any portion of the Site for any purpose not connected with the Works unless the prior written permission of the Engineer has been obtained.

Except with a written permission of the Architect / Engineer, which shall be given when necessary for the execution of the works, the sub-contractor's employees will not be permitted to enter any of the Employer's buildings or lands or sites under the control of the Employer, other sub-contractors or the Engineer. The sub-contractor shall warn his employees that any man found within such buildings or sites without authority is liable to be removed from the Works.

2.25 POSSESSION OF SITE

It shall be deemed that the prices entered by the sub-contractor for the completion of the works are inclusive of all required temporary supplies associated with retaining of essential services as may be directed by the Architect / Engineer or the Employer. All details shall be fully agreed as the works proceed to suit the operational situations as and when they arise.

2.26 INTERFERENCE WITH THE WORKS

The sub-contractor shall not interfere in any way with any existing Works whether the property of the Employer or of a third party and whether the position of such works is indicated to the sub-contractor by

the Architect or Engineer or not except where such interference is specifically described as part of the Works either in the contract or in any instruction from the Architect/Engineer.

2.27 WATER AND POWER FOR USE ON THE WORKS

Water for construction purposes and for use by the sub-contractor's staff during the contract period will be the responsibility of the contractor. The contractor shall make his own arrangements for connection to the nearest suitable water supply/main and for metering the water used. In this respect the sub-contractor shall liaise with main Contractor and the Employer who may be able to assist.

The sub-contractor shall be responsible for the supply of all electrical power for construction purposes prior to the issue of the Taking-Over Certificate.

2.28 TELEPHONE AND COMMUNICATIONS

The sub-contractor shall make his own arrangements for the provision of a telephone at the site, the sub-contractor being fully responsible for all charges and costs incurred in providing this facility. In this respect the sub-contractor shall liaise with the main contractor and the Employer who may be able to assist.

2.29 SITE OFFICES, WORKSHOP AND STORAGE

A space will be provided by the Main Contractor for the sub-contractor's site offices, workshops and storage. The sub-contractor shall be responsible for providing all buildings, fencing, etc that he may require and on completion of the Works shall be required to remove all such buildings, fencing, etc and to restore the land to its original condition.

The sub-contractor shall state, with his Tender, the areas that he requires for his site offices, workshops and storage. The areas of land available are limited and the Employer reserves the right to allocate areas of land smaller than the sub-contractor may require, in which case, the sub-contractor shall make such additional or alternative arrangements as may be necessary for his full requirements, all at his own cost.

2.30 SANITATION OF THE WORKS

The sanitation of the works shall be the responsibility of the contractor who shall arrange and maintain all required sanitation facilities to the satisfaction of the Local Authorities, Labour Department and Architect.

The Sub-contractor shall warn his employees and other specialists and sub-contractors that any employee found fouling the site shall be removed from the Site immediately.

In this respect, the sub-contractor shall arrange for erecting temporary toilet and ablution facilities, these facilities being connected, on a temporary basis, but to approval, into the existing foul sewage system. Full details shall be agreed. These temporary ablutions are a specific requirement of the Employer and shall therefore be provided for this duration of the contract, all items being removed at the completion of the Works and the existing system fully reinstated to its original condition.

2.31 PROTECTION OF WORKS

The sub-contractor shall carefully protect from injury by weather all work and materials which may be affected thereby and allow in his prices for all dams, pumping, shoring, temporary drains, sumps etc, necessary for the purpose, and shall clear away and make good at his own cost to the satisfaction of the Engineer all damage caused thereby.

2.32 SUNDRIES

The necessary holding down bolts, supporting brackets and templates, guards and screens, locks, piping, conduits, lamps and other requisite sundries whether specified in detail or not shall be provided, under the contract and it shall be deemed that the sub-contractor's prices, rates and the like include for all such items.

2.33 MAINTENANCE CONTRACT

The Employer will consider the introduction of long term maintenance contracts with specialist manufacturers and sub-contractors. In this respect the sub-contractor shall submit, with his tender, details of a planned maintenance contract that will take effect after the completion of the six-month maintenance period previously specified.

2.34 DELETION OF ITEMS FROM CONTRACT

Where Provisional Sum items have been identified within the Bills of Quantities these may be expended in whole, in part or may be totally deleted from the sub-contract works. In addition, certain items that have been designed, specified and included within the Bills of Quantities may finally be deleted from the sub-contract, as the Employer has not finally decided whether they are to be provided. It shall be deemed that the tender price entered by the sub-contractor has taken into account the possible deletion of these items, and Provisional Sum items, as no claims for loss of profit or any other such claim will be entertained.

2.35 AMBIENT CONDITIONS

The following climatic conditions apply at the site of the contract works and plant, equipment, apparatus and installation shall be suitable for these conditions:

CLIMATIC CONDITIONS	KISII TOWN
Maximum out door dry bulb Temperature, t_o	30˚C
Minimum Temperature	12˚C
Relative Humidity	41% - 97%
Altitude	1730 M ASL
Longitude	34˚ 47’ 01” E
Latitude	-0˚ 41’ 06” N
Max. solar radiation occurs during the month of February	

Extremely heavy rains fall during certain periods of the year and the contractor shall be deemed to have taken account of this fact both in his prices and his planning for the execution of the works.

2.36 SCHEDULES OF TECHNICAL DATA

Where included in the Tender Documents, Schedules of technical data shall be completed by all tenderers, otherwise the Tender may not receive full consideration, and will be liable to rejection.

2.37 COPIES OF ORDERS

Copies of all orders for major items of plant, equipment and materials placed with suppliers shall be provided in triplicate to the Engineer.

2.38 INSPECTION AND TESTS AT MANUFACTURER'S WORKS

The Engineer, and his duly authorised representative, shall have at all reasonable times access to the Contractor's premises to inspect and examine the materials and workmanship of the mechanical and electrical plant and equipment during its manufacture there; and if part of the plant and equipment is being manufactured on other premises, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the plant and equipment was manufactured on the Contractor's own premises. Such inspection, examination or testing, if made, shall not relieve the Contractor from any obligation under the Contract.

Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the Maker's works, to the relevant British Standard where applicable.

PART 3:
GENERAL SPECIFICATIONS
KISII CANCER CENTRE - KISII COUNTY, KENYA

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3. GENERAL SPECIFICATION FOR AIR-CONDITIONING & MECHANICAL VENTILATION

3.1 GENERAL

This section specifies the general requirements for air conditioning and mechanical ventilation plant, equipment and materials forming part of the sub-contract works and shall apply except where specifically stated elsewhere in the specification or on the contract drawings.

3.2 INSTALLATION

Installation of all ductwork, plant and equipment shall be carried out under adequate supervision from skilled staff to the relevant codes and standards specified herein.

The sub-contractor shall be responsible for ensuring that sufficient provision is made to prevent the transmission of vibration from equipment to the supporting structure. In the case of fans, this shall be done by rot and vermin proof flexible connections and anti-vibration mountings of an approved type.

The Sub-contractor shall ensure that all ducting systems are provided with sufficient access hatches complete with covers, for maintenance purposes.

Dampers and other user equipment shall be installed with adequate access for operation and maintenance. Where dampers and other operational equipment are unavoidably installed beyond normal reach and in such a position as to be difficult to reach from a short step ladder, extension spindles shall be provided.

The variety and type of supports for ducts, pipework, fans, pumps etc. shall be kept to a minimum and their design shall be such as to facilitate quick and secure fixing to metal, concrete, brickwork or wood.

Where the design of the structure is in reinforced concrete, supports shall be secured to the structure by means of redheads, rawbolts or other approved means.

Where the sub-contractor proposes to secure his supports by other means than to the main structural concrete, he shall consult with the Engineer before proceeding.

3.3 TESTING AND INSPECTION

3.3.1 Site Tests

The sub-contractor shall supply all instruments and equipment necessary to carry out site tests and shall arrange with other sub-contractors for the testing of associated equipment which may affect the performance of the plant installed under this sub-contract works.

3.3.2 Site Tests – Fans

All fans shall be charged with a suitable lubricant and shall be tested upon completion of the ancillary system erection to ascertain that the performance of each fan complies with the requirements of the specification.

3.3.3 Completion of Works – Balancing and Commissioning

Following the site tests and prior to handover, mechanical ventilation or air conditioning systems shall be balanced by means of grilles, dampers, valves and other special controls installed, so as to give the required air /water flow rates and where applicable, the desired temperatures, pressures and humidity conditions in all areas served by the said systems.

The complete system shall be balanced and commissioned as a whole. Sectional balancing and commissioning on any one part of the system where this excludes final complete system balancing and commissioning, shall not be accepted.

Test volumes within ducts shall be within +5% and –5% of the design volumes, and volumes at grilles and diffusers shall be within +10% and –10% of the design volumes.

When the system has been balanced to the satisfaction of the Engineer, it shall be run under complete automatic control for 72 hours continuous operation to ascertain any faults in operation before acceptance and handover. Any faults discovered during this time shall be corrected and a further test or tests of 72 hours duration shall be carried out to ensure satisfactory operation, all at the expense of the sub-contractor.

3.4 DUCTWORK, DAMPERS AND TERMINAL DEVICES

3.4.1 FABRICATION DRAWINGS

The ductwork layout indicated on the drawings is for tendering purposes only. All relevant dimensions are to be verified by the ductwork manufacturer, from site dimensions, before ductwork is manufactured unless otherwise stated.

3.4.2 SHEET METAL DUCTWORK

Ductwork materials and construction shall comply with HVCA Specification DW/144. The ductwork classification shall be as indicated within this Specification. Unless otherwise indicated within this Specification ductwork shall be delivered to site cleaned to 'Intermediate Level' to HVCA DW/TM2.

Site storage areas shall comply with HVCA DW/144.

Unless otherwise indicated within this Specification, the methods of construction for seams and joints shall be in accordance with HVCA Specification DW/144. Materials used for ductwork construction shall be free from blisters, pits and surface imperfections.

All raw edges of ductwork and areas where galvanising has been destroyed shall be cleaned, prepared and painted with zinc-rich paint at works.

Internal roughness and obstructions to airflow, (other than dampers, splitters, vanes, etc.), will not be accepted for ductwork constructed from sheet materials. Sharp edges or corners on the outside of ductwork, fittings and supports will not be accepted.

Perforated rivets shall not be used in the manufacture or erection of ductwork.

Ductwork connecting to or enclosing a flameproof air filter medium, shall be not less than 1.6mm thickness for at least 1.8m upstream and 1.8m downstream of the filter.

Square and 90 degree branches shall not be used.

Connection points for instruments and controls shall be reinforced to provide adequate support.

Bolted, gasket, angle section flanged joints shall be provided for dismantling.

3.4.3 INSTALLATION

Ductwork supports shall be provided close to dampers, diffusers, etc., in addition to those hangers and supports required for ductwork generally. Duct connections between individual components of air handling equipment and connections between equipment and ductwork shall be made with bolted, gasketted, angle section flanged joints.

Flexible joints to fans shall be tightly clamped to prevent air gaps. The material, which shall have a fire penetration time of at least 15 minutes when tested in accordance with BS 476:1987: Part 7 and Part 22, shall remain flexible and without strain or distortion.

At each point where a duct passes through a roof or external wall, a weather cravat or other purpose-made arrangement shall ensure weatherproof fixing.

Supports for floor-mounted ductwork shall be provided and flange-bolted to support pads or plinths.

3.4.4 INSPECTION AND TESTS

The Contractor shall issue a certificate confirming that all ductwork constructions comply with the relevant HVCA Specification DW/144 tabulated gauges. Notwithstanding this, the Engineer reserves the right to have random discs of 50mm diameter, (or equivalent), cut at site in any ductwork range for the purpose of checking the gauge of the material used. Such check cuts shall be made good by covering with 80mm diameter, (or equivalent), plate of 'ductwork' gauge secured with self-tapping screws and sealed with mastic.

Ductwork systems or sections thereof shall be leak tested in accordance with:

a) Medium and high pressure/velocity ductwork systems shall be tested for air leakage in accordance with HVCA Specification DW/144 using method described in HVCA publication DW/143. Low pressure/velocity ductwork systems shall be tested for air leakage by the same methods where indicated within HVCA Specification DW/144 using method described in HVCA publication DW/143.
b) Installations or sections of air distribution systems which will be embedded in the structure or concealed in permanently sealed ducts, trenches, roof spaces etc. In addition to the above-specified tests, they shall be individually tested as they are installed and before being embedded or concealed.

3.4.5 PLASTICS DUCTWORK

Where plastic ductwork is specified, the materials and constructions shall comply with HVCA Specification DW/151.

Plastic ductwork and all associated moulded or extruded sections; angles and fittings shall be suitable for the range of substances conveyed and the conditions as indicated within this Specification and/or drawings.

Unless otherwise indicated within this Specification and/or detailed on drawings, sheet material shall be pressed unplasticised PVC sheet complying with BS 3757:1978. Where PVC ductwork is thermally insulated or is not readily visible, Type A2 sheet shall be used. Elsewhere, Type A1 sheet shall be used.

Any plastics ductwork systems incorporating a heater battery shall be installed such that the heating effect of the battery or its casing does not impair any part of the system.

Where indicated on the drawings, ductwork shall be reinforced with glass fibre /resin laminate.

3.4.6 ALUMINIUM DUCTWORK

Where aluminium ductwork is specified, the grade of aluminium shall be as indicated in and shall fully comply with HVCA Specification DW/144.

3.4.7 PVC COATED STEEL SHEET DUCTWORK

Where PVC coated steel sheet ductwork is specified, the sheet thickness and construction specification shall be as for galvanised steel sheet ductwork of the same size. The steel sheet shall be galvanised and coated with PVC film at least 0.25mm thick on one or both sides as indicated on the drawings. Care shall be taken to preserve the coating during ductwork manufacture and erection.

3.4.8 STEEL DUCTWORK, GALVANISED AFTER MANUFACTURE

Where galvanised after manufacture steel ductwork is specified, it shall comply with HVCA Specification DW/144.

3.4.9 STAINLESS STEEL DUCTWORK

Where stainless steel ductwork is specified, the grade of stainless steel shall be as indicated in and shall fully comply with HVCA Specification DW/144.

3.4.10 BENDABLE DUCTS AND FLEXIBLE DUCTS

Bendable ducts and flexible ducts shall be metal, plastic coated metal or non-metallic type.

Where bendable ducts and flexible ducts are specified, the internal diameter of the duct shall be equal to the external diameter of the rigid duct or equipment spigot. Flexible ducts in other situations shall only be used with the approval of the Engineer. The maximum length of any individual duct shall not exceed 1m.

Non-metallic ducts shall have a liner and a cover of tough tear-resistant fabric. The fabric shall be impregnated and coated with plastics and reinforced with a bonded galvanised steel spring, stainless steel or other approved wire helix between the liner and the cover. An outer helix of glass fibre cord, or equal, shall be bonded to ensure regular convolutions. Flexible ductwork without a liner may be used subject to compliance with all the other appropriate requirements of this section.

Metallic ducts shall consist of corrugated metal tubing of stainless steel, aluminium, galvanised steel or aluminium coated steel. The metal surface(s) may be coated with a plastic material.

The frictional resistance to airflow per unit length of bendable duct or flexible duct shall not exceed 150% of the frictional resistance per unit length of galvanized steel duct of similar diameter. The radius ratio R/D for bends shall be not less than 2, where R is the centre line radius and D is the diameter of the duct.

The leakage from any section of bendable duct or flexible duct shall meet the requirements for air tightness applicable to rigid ductwork for the pressure classification specified.

Unless otherwise indicated within this Specification, bendable ducts and flexible ducts shall be suitable for an operating temperature range of -5^{o}C to +90^{o}C and shall comply with BS 476:1987 as follows:

a) Part 12 — having Class P rating;
b) Part 6 — having an index of performance (I) not exceeding 12, of which not more than 6 should be derived from the initial period of test;
c) Part 7 — be Class 1 rated (surface of very low flame spread).

Test holes shall not be formed in bendable nor flexible ductwork.

3.4.11 DAMPERS

4.4.11.1. General

The general constructional requirements of dampers shall be in accordance with HVCA Specification DW/144. The respective functions and types shall be as indicated either within the Equipment Schedules and/or detailed on the drawings. Damper frames and blades shall be constructed to ensure rigidity and prevent distortion and jamming in operation. The blades shall be securely fixed to the operating spindles so that differential movement cannot occur. Spindles shall be carried in non-ferrous or nylon plain bearings or in ball bearings.
An access opening shall be provided for each damper and shall be located to provide access for inspection and maintenance.

Manually and automatically operated dampers shall include a means for indicating externally the position of the blades. Manual dampers shall include a device for positioning and locking the damper blades. Ratchet and pawl locking devices are not acceptable.

The position of all dampers, as set after final regulation, shall be permanently marked at the adjusting device.

Balancing dampers shall be fitted in each branch from a main or sub-main and wherever indicated on the drawings.

Unless otherwise indicated within this Specification, air leakage through dampers when in the closed position shall not exceed 5% of the maximum design air volume flow rate at the maximum design air total pressure. Where indicated within this Specification, air leakage tests to verify compliance with this Clause, shall be carried out in accordance with BS 6821:1988.

4.4.11.2. Non-return dampers

Non-return dampers shall be of the motorised type and shall be arranged to close on detection of failure of airflow except those for small packaged duplicate-fan extract units.

4.4.11.3. **Fire dampers**

Unless otherwise indicated within this Specification, fire dampers used singly or in combination shall have an overall fire rating not less than 2 hours. In all cases, evidence of fire rating in accordance with BS 476:1987: Part 22 shall be provided.

Unless otherwise indicated within this Specification and/or the Equipment Schedules, each fire damper shall be held in the open position by a corrosion-resistant retaining device incorporating a replaceable fusible element. The fusible element shall operate at a temperature of 72^{o}C.

No duct lining or bendable duct or flexible duct shall be installed within lm of a fire damper.

Fire dampers shall be constructed from either a corrosion-resistant material such as stainless steel, or be galvanised or otherwise treated to minimise corrosion. The dampers shall be housed in a rigid framed, corrosion-resistant casing which shall not distort under fire conditions. Provisions shall be made to accommodate expansion of the damper blade(s) within the casing in fire conditions. A fire damper installation frame shall also incorporate provision for expansion within the surrounding structure, together with lugs for building into the structure.

Fire damper assemblies for installation in corrosive environments, or where corrosive agents occur in the ducted air, shall be fabricated from material or be coated with a protective finish resistant to the corrosive substances and conditions indicated.

Each fire damper casing shall be clearly marked with a permanent indication of the correct fixing attitude of the damper, the direction of air flow and the side at which access or maintenance openings shall be located.

The installer shall demonstrate that satisfactory access for operating and resetting of all dampers in their installed locations has been provided.

The folded continuous interlocked blade type of damper may be used for vertical or horizontal duct applications. A stainless steel spring or springs shall provide the closing force for these types of dampers. An automatic locking device shall be provided to ensure that the blades are firmly held in the closed position after release. In the open (normal) position, all blades shall be completely out of the air stream. This type of damper only shall be used in high velocity systems.

Spring-actuated pivoted single blade or multi-bladed dampers may be used for vertical or horizontal duct applications. Multi-bladed dampers shall be provided with a means to ensure that all blades close simultaneously.

Gravity-operated multi-bladed fire dampers shall only be used in horizontal ducts. Gravity-operated single blade dampers may be used for both vertical and horizontal ducts, provided that means are incorporated which ensure reliable and positive closure when operating in maximum air flow rate conditions.

Where gravity acting, off-centre pivoted dampers incorporate spindle bearings, long-term corrosion effects shall be minimised by choice of materials. Bearings shall be sealed and capped to exclude dirt and dust. Damper blades shall close to comply with the stability and integrity requirements of BS 476:1987: Part 22.

Where indicated in the Equipment Schedules, provision shall be made to remotely indicate that a fire damper is in the closed position.

Intumescent type fire dampers shall only be used where indicated within this Specification and/or the drawings.

3.4.12 ACCESS OPENINGS, CLEANING AND INSPECTION COVERS

All access openings shall have rigid frames with air sealed covers, designed for ease of removal and re-fitting, secured with a minimum number of proprietary quick-release captive fastenings consistent with effective air sealing. Set screws, set bolts or self-tapping screws will not be acceptable as fixing devices.

Access openings shall be provided as stated in HVCA Specification DW/144. Access openings for cleaning purposes shall be as indicated on the drawings.

Hinged access doors shall be provided where indicated on the drawings.

Inspection covers shall be provided where indicated within this Specification and/or on the drawings.

3.4.13 HOODS

Hoods shall be of the material(s) indicated within this Specification, rigidly formed and be supported independently of ductwork. Unless otherwise indicated within this Specification and/or the drawings, support shall be provided either from above or from a sidewall. Horizontal joints in sheets are not acceptable. The type and size of hood shall be as indicated within the Equipment Schedules and/or detailed on the drawings, but the exact position shall be approved by the Engineer.

Hoods for kitchen equipment, and for the extraction of vapours, shall have an internal perimeter gutter with a plugged drain connection. Hoods shall be non-combustible and comply with BS 476:1987: Part 22 and BS 476:1987: Part 3, Class AA (without suffix X).

Grease filters, shall be incorporated as specified and be in accordance with:

a) Grease eliminators shall be of the corrugated plate type, crimped wire mesh type or baffle type and be entirely of metal. All materials used shall be resistant to or protected against corrosion. Where grease eliminators are fitted in kitchen hoods, the assembly shall include a drip tray and the element shall be secured in the frame by quick-release clips.
b) In all cases, the grease eliminator shall be readily accessible and removable for cleaning.
c) The entire framework shall be securely fixed in position with all edges and joints effectively sealed to prevent air leakage.
d) The retaining clips, or other securing device, shall be capable of pulling the filter on to its seating and shall exert equal pressure on all faces
e) In all cases, the grease eliminators shall be flameproof, the frames, casings and filter cell holding frames shall be classified non-combustible when tested in accordance with BS 476:1987: Part 4. Fire dampers shall be provided in locations as indicated on the drawings and/or this Specification.

Hoods provided over deep pan fryers shall be vented direct to the open air by the shortest possible route and shall not incorporate a fire damper.

Gutter drains shall be extended to near floor level after installation of the hood.
Suitable electric lighting shall be provided in hoods as indicated within this Specification and/or detailed on the drawings.

Cleaning doors shall be provided in ducts connected to hoods and canopies as indicated on the drawings.

3.4.14 TEST HOLES

Test holes for plant system commissioning shall be fitted with 13mm diameter easily removable rubber or neoprene sealing plugs. Test holes shall be provided in locations stated in HVCA Specification DW/144, and additionally in all branch ducts in locations not unduly influenced by local fittings. Further requirements for test holes shall be as indicated within this Specification and/or as detailed on the drawings.

3.4.15 IDENTIFICATION

Ductwork identification shall be in accordance with:

a) Identification coding for ductwork, including thermal insulation, shall be in accordance with the recommendations in Appendix C of HVCA Specification DW/144.
b) All ductwork shall be identified by colour triangles with a side length of at least 150mm. The triangles shall be spaced and located to permit ready identification of the services, particularly adjacent to equipment positions, at service junctions, at wall penetrations and at all changes of direction.
c) In addition to the colour triangles required above ductwork in plant rooms and service areas, shall be indelibly and legibly marked with black or white letters and arrows, to show the type of service and the direction of fluid flow. Lettering shall be a minimum of 50mm in height. Services shall be shown as follows:

Supply air:	SA
Return or re-circulated air:	RA
Fresh air:	FA
Exhaust air:	EA

3.4.16 AIR TERMINAL DEVICES

4.4.16.1. General

The testing and rating of air terminal devices shall be in accordance with BS 4773: Part 1 and BS EN ISO 5135.

Sizes of all terminal devices shall be based on the dimensions and/or duty indicated within the Equipment Schedules, and shall provide the air volume flow rate, air diffusion and any other requirements as specified. The indicated sound power levels shall not be exceeded.

The materials of construction shall be steel, aluminium or plastics as indicated within the Equipment Schedules. All items shall be protected against corrosion and be provided in the fully furnished condition. Visible internal fixings shall be a matt black finish and to the Engineers requirements.

The full perimeter of all air terminal devices located on walls or ceilings shall be provided with a resilient sealing strip. Where indicated within the Equipment Schedules, special devices shall be incorporated to prevent pattern staining.

Each air terminal device shall be firmly fixed in position, be level and aligned with adjacent terminals.

Press-in spring clip fixings are not acceptable other than for sill or floor mounted air terminals. Grille or diffuser cones shall be removable where indicated within the Equipment Schedules.

Damper adjustment mechanisms shall be concealed from casual view, finished to the Engineers requirement and be operable by hexagonal wrench or screwdriver. For up to ten units of any

particular type of air grille, register or diffuser, one set of any special tools required for adjusting shall be provided; from eleven to twenty-four, two sets; twenty-five and over, three sets.

4.4.16.2. Grilles and Registers

Grilles and registers for supply air shall have two sets of adjustable blades, one set horizontal and one set vertical. Unless otherwise indicated within the Equipment Schedules and /or drawings, the airflow rate controller for supply air registers shall be a damper of the opposed blade multi-leaf type or rhomboidal type.

Grilles and registers for extract air shall have a single set of adjustable blades either horizontal or vertical, or a lattice or egg crate front as indicated within the Equipment Schedules. The airflow rate controller for extract air registers shall be a damper of the opposed blade multi-leaf type.

The blades of all grilles and registers shall be adjustable from the front and shall have a friction device to retain set positions. The airflow rate controller of all registers shall be adjustable from the front.

4.4.16.3. Diffusers

Unless otherwise indicated within the Equipment Schedules, each diffuser shall be provided with an airflow rate controller and a means of altering the discharge airflow pattern. All controllers shall be adjustable from the front of the diffuser. Where a diffuser is directly connected to a stub duct, which has a straight length of less than two equivalent diameters, an equalising deflector, shall be used.

Cone type diffusers shall be provided, where indicated within the Equipment Schedules, with finishes as specified.

Linear diffusers shall be of the fixed blade type, or shall include means of independently adjusting the direction of the air jets, as indicated on the drawings. The method of air volume flow rate control shall be as indicated within the Equipment Schedule. Where linear diffusers are mounted in a continuous line, there shall be provision for ensuring alignment between consecutive diffusers and each diffuser shall be provided with means to ensure uniform airflow distribution along the diffuser. Plenum boxes and duct connections shall be in accordance with manufacturers' recommendations.

Circular diffusers, with adjustable airflow pattern, shall have the cone retained by a screwed spindle fitted with upper and lower stop pins or other approved method.

4.4.16.4. Swirl Type Diffusers

Swirl type diffusers shall be floor or ceiling mounted type. Floor diffusers shall have removable dust boxes. The units shall be of rigid box construction with front plate containing air guides to produce the performance required.

4.4.16.5. Displacement Ventilators

Displacement ventilators shall be of galvanised mild steel sheet construction with perforated face panels, base plate and circular connection collar for ducts.

Ventilators shall contain low resistance baffle, equalising grid or other device to ensure even distribution over perforated face panels.

Perforated face panels to be easy removable type for cleaning and maintenance or replacement of air distribution component.

Outlet surfaces shall be as shapes indicated within the Equipment Schedules and/or the detailed on the drawings. Ventilators shall be suitable for floor mounting.

Noise levels shall not exceed NR ratings indicated within the Equipment Schedules.

4.4.16.6. External Louvres

All air intake and exhaust points shall be protected with louvres designed to prevent ingress of rain. Ductwork immediately behind a vertical intake or exhaust louvre shall be painted on all internal surfaces with epoxy resin or bitumastic paint for a length from the louvre equal to the louvre height, or to the nearest equipment item, whichever is the lesser. The bottom side of the ductwork shall have a 1~ degree minimum slope towards the louvre.

Frames and blades shall be fabricated from galvanised mild steel sections and sheet, or from aluminium alloy of adequate stiffness to prevent vibration and/or damage. All louvres shall be fully protected against corrosion and be provided in the fully finished condition indicated within the Equipment Schedules.

Galvanised mild steel louvres shall be assembled with non-corrodible bolts. Vermin screens shall be fitted to all external louvres and shall be removable for cleaning.

The method of fixing louvres shall be by bolting through the casing flange or side casing to structural members. An effective weather and acoustic seal shall be achieved using packing and filling materials as necessary.

Acoustic louvres shall be provided where indicated and have a performance as specified within the Equipment Schedules. The louvers shall consist of a rigid casing housing double-skin blades having plain top surfaces and shaped, perforated undersides to achieve maximum attenuation, utilising infill material packed in sealed plastic film containers. In fill, material shall comply with the Vibration Isolation and Noise Insulation Section of this Specification. Acoustic performance shall be as indicated within the Equipment Schedules. Test results sheets shall be available.

4.4.16.7. Roof Cowls

Cowls shall be manufactured from pressed steel sheet (galvanised after manufacture, and /or painted in accordance with the finishing schedules), spun aluminium or aluminium sheet, as indicated within the Equipment Schedules and /or as detailed on the drawings. Alternatively, or where indicated, construction shall be from self-coloured moulded glass reinforced plastics to BS 3532:1990 assembled with fittings as compatible, and of non-corroding materials, to suit the application.

The exterior shape and the mounting and fixing arrangements of the cowls shall withstand the maximum wind speed indicated and shall be suitable for the roof structure.

Back draught dampers shall be fitted to discharge cowls and shall be suitable for the type and conditions of the gases handled. Automatically controlled opening shall be provided where indicated within the Equipment Schedules and/or as detailed on the drawings. The dampers, when closed, shall limit leakage to 5% of the design airflow.

Vermin screens shall be fitted to all roof cowls and shall be removable for cleaning.

3.4.17 INSULATION

4.4.17.1. General Description

All heated, cooled, and recirculated air ductwork shall be insulated. Insulation shall be of 25mm thick expanded polystyrene sheet, or spray applied polyurethane foam to a uniform thickness of 25mm. Polystyrene shall be fixed so that the edges butt closely without gaps and the insulation shall overlap at corners by the thickness of the insulation. The sheet shall be fixed by means of a suitable adhesive and plastic impingement pins attached to the ductwork.

4.4.17.2. Ductwork in Plant Rooms

The insulation described above shall be finished by the application of a 15mm thick layer of hard setting plastic compound trowelled to a smooth finish. All corners shall be protected by setting in a 1mm thick aluminium angle strip into the hard setting finish. Insulation shall be bevelled to

angle 45° at all connecting flanges, access hatches and all other places where operation or maintenance is likely to cause the breaking of the insulation.

The insulation shall then be given a vapour sealing by the application of two coats of anti-condensation paint.

4.4.17.3. Ductwork External to Plants Rooms

The insulation described above shall be finished by the application of two coats of bitumastic.

3.4.18 FINISH PAINTING

Upon completion of the installation and after all tests have been carried out to the satisfaction of the Engineer, the plant, equipment, supports, etc., shall be examined and all priming coats damaged during erection made good.

Any plant or equipment, ductwork, etc., which is to be insulated, shall have the priming paint protection made good before the application of the insulation.

After the above procedures have been carried out to the satisfaction of the Engineer, the various surfaces shall be given the necessary preparation as recommended by the paint and insulation manufacturers and finish painted in colours to be agreed between the sub-contractor and the Engineer at a later date.

For the purposes of the specification, however, it shall be deemed that the sub-contractor's tender price was based on the identification requirements for the various services in Code of Practice DW/161 Identification of Ductwork as published by the H.V.C.A.

TABLE FOR DIMENSIONS OF MILD STEEL SHEET METAL DUCTS

Size of Duct	Gauge	Stiffening for ducts jointed: in all cases an angle girth should be secured at the slip joint.	Angle iron flanged joint where specified.
Rectangular duct longer side up to 300mm	22 (0.711mm)	None	25 x 25 x 3mm
Over 300mm and up to 680mm	20 (0.914mm)	25mm x 25mm angle girth at slip joints over 600mm wide at approx. 2000mm center.	25 x 25 x 3mm
Over 680mm and up to 825mm	18 (1.219mm)	Slip joints at approx. 2000mm centers.	25 x 25 x 3mm
Over 825mm and up to 1000mm	18 (1.219mm)	32mm x 32mm x 6mm angle girth at slip joints at approx. 2000mm centers.	32 x 32 x 5mm
Over 1000mm and up to 1500mm	16 (1.626mm)	32mm x 32mm x 6mm angle girth at slip joints at approx. 1000mm centers.	40 x 40 x 6mm
Over 1500mm and up to 1800mm	16 (1.626mm)	40mm x 40mm x 6mm angle girth at slip joints at approx. 1000mm centers.	40 x 40 x 6mm
Over 1800mm	16 (1.626mm)	40mm x 40mm x 6mm angle fixed diagonally to stop the bottom plates.	50 x 50 x 6mm

3.5 FANS

3.5.1 GENERAL

Unless otherwise indicated the requirements of this section shall not apply to fans having a duty air flow rate of less than 0.3m^3 per second.

Mechanical and electrical safety provisions for fans shall be in accordance with BS 848: Part 5. Fans shall be 'type' tested in accordance with BS 848: Part 1 and Part 2 and be selected to deliver the required air volume flow rate and meet the noise level indicated within the Equipment

Schedules. Fan curves shall be submitted to indicate performance under all likely operating conditions.

Values of resistance to airflow of items of equipment, ductwork and/or the total external distribution system, are indicated within the Equipment Schedules for tender purposes only. The total system resistance shall be verified by the Contractor, to ensure that fans provided are capable of delivering the required air volume when operating against the actual total system resistance. The Contractor shall compensate for the manufacturers' certified resistance of all equipment being supplied and any other variation to the total system resistance caused by changes to fittings, ductwork layouts or ductwork sizes.

Fans shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty, during starting, during stopping and during speed and duty changes. Additionally, belt-driven fans shall be capable of running continuously at 10% in excess of the selected duty speed and shall have a minimum of two belts.

Fans shall be installed using bolts, nuts and washers with all nuts properly locked and secured. All 'as cast' bearing surfaces for bolt heads and washers shall be machine counter faced. Holding-down bolts for fans and motors shall be provided with means to prevent the bolts turning when the nuts are tightened. All fans shall be mounted on adequately sized anti-vibration mountings.

The shaft and impeller assembly of all fans shall be statically and dynamically balanced to BS 6861: Part 1. Where indicated within this Specification and/or Equipment Schedules, the limits of vibration severity shall be in accordance with BS 7854: Part 1.

Fan bearings shall be of a type suitable for the size, speed, loads and discharge angle of the fan and shall be greased /oil ball and /or roller type, oil lubricated sleeve type or sealed type where approved. Bearing housings shall be precision aligned and arranged so that bearings may be replaced without the need for realignment. Bearing housings shall be protected against the ingress of dust. For grease lubricated systems, the bearings shall be provided with grease in the quantity and quality recommended by the bearing manufacturer. Oil lubricated systems shall have an adequate reservoir of oil. All bearing lubricators shall be located to facilitate maintenance.

Finishes and materials of construction shall not be affected by gases handled by the fan or the local environment.

Flexible connections for fans shall be in accordance with:

a) Flexible connections shall be non-metallic ducts having a liner and a cover of tough tear-resistant fabric. The fabric shall be impregnated and coated with plastics and reinforced with a bonded galvanised steel spring, stainless steel or other approved wire helix between the liner and the cover. An outer helix of glass fibre cord, or equal, shall be bonded to ensure regular convolutions. Flexible ductwork without a liner may be used subject to compliance with all the other appropriate requirements of this section.
b) The leakage from any section of flexible duct shall meet the requirements for air tightness applicable to rigid ductwork for the pressure classification specified.
c) Unless otherwise indicated within this Specification and /or Equipment Schedules, flexible connections shall be suitable for an operating temperature range of -5 ^{o}C to +90^{o}C and shall comply with BS 476:1987 as follows:
    i) Part 12—having Class P rating;
    ii) Part 6—having an index of performance (1) not exceeding 12, of which not more than 6 should be derived from the initial period of test;
    iii) Part 7—be Class 1 rated (surface of very low flame spread).

3.5.2 CENTRIFUGAL FANS

Centrifugal fans for high pressure /high velocity systems, (as defined within HVCA Specification DW/144), shall be of the backward bladed type.

Unless otherwise indicated within this Specification and /or Equipment Schedules, centrifugal fans consuming more than 7.5kW at the fan shaft shall be of the backward bladed type selected for operation at a fan total efficiency not less than 75%.

Fan casings shall be out of mild steel sheet, with welded or riveted joints and welded angle stiffeners, constructed to permit withdrawal of the fan impeller. Fans not in air handling units shall have flanged outlet connections and spigot inlet connections unless otherwise indicated within this Specification and/or Equipment Schedules. For negative pressure in excess of 500 Pa, the inlet connection shall be flanged. All flanged connections shall be in accordance with BS 6339. A plugged drain shall be fitted at the lowest point in the casing. Permanent indicators shall show the direction of rotation of the impeller. Casings shall have access panels incorporating air seals to facilitate cleaning and maintenance of the impeller. Scrolls formed from galvanised mild steel sheet with lock formed joints and spot welded supports and bases shall not be used for fans with a static pressure greater than 2 kPa. For toxic or hazardous application fan casing shall be gas tight all welded construction.

Impellers shall be of mild steel protected against corrosion or aluminium alloy. Impeller cage braces shall be bolted, riveted or welded to the cage and hub. Stressed wire or threaded rod bracing shall not be used. Bolted assemblies shall have locking devices.

Impellers of fans consuming more than 1kW at the fan shaft shall be keyed to the driving shaft or fixed with tapered bush fittings.

Each fan impeller shall have a separate shaft. Where necessary, fan shafts shall be connected with flexible couplings to ensure correct alignment.

Each fan impeller shall be supported by an individual bearing system.

Plummer block bearings or similar split bearing housings shall be used on fans consuming more than 4kW at the fan shaft. Where indicated within this Specification and/or Equipment Schedules ‘sealed for life’ rubber bushed bearings are acceptable

Rubber bushed bearing housings with lateral deflections shall not be used on belt-driven fans consuming more than 1kW at the fan shaft.

Belt-driven centrifugal fans and drive motors shall be located on a common base.

3.5.3 AXIAL FLOW FANS

Fan casings shall be rigidly constructed of mild steel protected against corrosion or aluminium alloy and shall be stiffened and braced where necessary to minimise drumming and vibration. Casings shall be fully airtight and flanged at each end. Mounting feet shall be provided where necessary for bolting to a base or supports. For in-duct mounting, the length of the fan casing shall be greater than the combined length of the impeller(s) and motor(s). Electrical connections to the motors shall be through flexible conduit to external galvanised mild steel or plastics terminal box secured to the casing.

Provision shall be made for inspection of the fan impeller and motor. A removable inspection panel incorporating an air seal shall be fitted to casings 450mm diameter and above.

Impellers shall be of mild steel protected against corrosion, aluminium or moulded reinforced plastics. The blades shall be securely fixed to the hub. Alternatively, the blades and the hub shall be formed in one piece. The hub shall be securely fixed to the shaft. Blades shall be of aerofoil section and where indicated within this Specification and/or Equipment Schedules shall be capable of pitch adjustment.

Drive motors for axial flow fans of the bifurcated type shall be located out of the air stream. Casings shall be of the same thickness throughout unless otherwise indicated within this Specification and/or Equipment Schedules, and shall extend for the overall length of the impeller, hub, and motor protection tunnel where applicable, and have circular flanged ends. Casings shall

be mild steel with continuously welded joints and be lined or finished as indicated within this Specification and/or Equipment Schedules. The impeller shaft shall have a seal at the tunnel wall to prevent leakage in either direction between the motor tunnel and the fan interior.

3.5.4 IN-LINE CENTRIFUGAL AND MIXED FLOW FANS

Fan casings shall be rigidly constructed of mild steel protected against corrosion or aluminium alloy and shall be stiffened and braced where necessary to minimise drumming and vibration. Mounting feet shall be provided where necessary for bolting to a base or supports. Each inlet and outlet shall terminate in a flange to BS 6339 to facilitate removal. Stator vanes shall be of mild steel or aluminium alloy.
Provision shall be made for inspection of the fan impeller and motor. Casings shall have an access panel incorporating an air seal to facilitate cleaning and maintenance. A removable inspection panel incorporating an air seal shall be fitted to casings 450mm diameter and above.

Fans connected at both ends to ducted systems shall have circular cross section casings, which cover the overall length of the impeller, impeller hub, motor and any inlet cones and discharge straightening vanes.

Impellers shall be mild steel protected against corrosion or aluminium with blades welded or riveted to the impeller hub and shroud. Impellers with an outside diameter 500mm or less may be die-cast aluminium with a fitted shroud.

Electrical connections to fans with direct drive motors or motors mounted inside the casing, shall be through flexible conduit to an external galvanized mild steel or plastics terminal box secured to the fan casing.

Fans driven by externally mounted motors shall have twin ball or roller bearing mounted steel impeller shafts. The drives shall be so arranged to minimise air leakage and allow access to pulleys and belts.

3.5.5 PROPELLER FANS

Propeller fans shall be ring mounted or diaphragm mounted as indicated within this Specification and/or Equipment Schedules. Impellers shall be of mild steel protected against corrosion, aluminium or plastics. The blades shall be securely fixed to the hub. Alternatively, the hub and blades shall be formed in one piece. Shafts shall be fitted with lipped slinger rings shaped to suit the fan-mounting attitude. Vertical-shaft fans, with the impeller mounted above the motor, shall be fitted with an impeller spinner with a watertight seal against the motor shaft.

3.5.6 ANTI-VIBRATION PROVISIONS

All dynamic machinery shall be isolated from the building structure by vibration isolators and/ or vibration isolation materials which shall be purpose-designed and selected to suit the machinery. Where mat type isolation materials are used, the Contractor shall supply the materials and shall be responsible for their correct positions and installation. All other vibration isolators shall be both supplied and installed by the Contractor. Isolation efficiency of anti-vibration devices and materials shall be as indicated within this Specification and/or Equipment Schedules.

For fans and air distribution systems, flexible joints shall be used between the fan outlet and the fixed casing.

3.5.7 Noise

Plant and equipment shall be selected and installed to ensure that the noise level in the spaces served, in any adjacent buildings and within plant rooms do not exceed the recommended maximum acceptable noise rating (NR). The maximum acceptable noise ratings are as specified within the building regulations. Sound power level information for plant and equipment shall be stated in the Equipment Schedules. Sound pressure level data is not acceptable

3.6 CIRCULAR AND RECTANGULAR ATTENUATORS

Casings shall be of not less than 0.8mm thickness galvanised mild steel sheet. Joints and seams shall be designed and constructed to minimise air leakage by use of mastic or other suitable sealing method. End flanges shall be welded to the casings with fixing details and construction methods in accordance with HVCA Specification DW/144. Welding areas shall be cleaned and coated with zinc-rich paint.

Acoustic material must not break up, erode or migrate at up to and including 150% of full duty air flow or at up to and including 100% relative humidity. An impervious envelope shall be fitted over the following acoustic fill:

a) Mineral fibre insulation.
b) Open-cell acoustic/thermal foam insulation that is not supplied complete with an inherent PVC sprayed vapour barrier or flexible polyurethane film.

Inspection covers shall be provided at both ends of attenuators, and they shall be in accordance with:

a) All access openings shall have rigid frames with air sealed covers, designed for ease of removal and re-fitting, secured with a minimum number of proprietary quick-release captive fastenings consistent with effective air sealing. Set screws, set bolts or self-tapping screws will not be acceptable as fixing devices.
b) Access openings shall be provided as stated in HVCA Specification DW/144.
c) Hinged inspection access doors shall be provided where indicated on the drawings.

The dynamic insertion loss of attenuators shall include the effect of any facing materials.

Vapour barriers which are not an inherent part of the acoustic material, shall be of minimum thickness not exceeding 0.07mm and shall be installed unstressed. The material shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476:1987: Part 7 and shall not emit toxic or hazardous fumes if ignited. Membranes used shall be suitably supported and fixed. Any loss of acoustic performance due to this treatment will be deemed to be accommodated in the overall performance of the noise control equipment selected by the Contractor.

Splitter elements in straight rectangular attenuators shall stand vertically, and shall be a tight fit within the casing. L-section and T-section splitter attenuators shall be designed for smooth airflow. Splitters in bend attenuators shall be fitted perpendicular to the plane of the bend. Where splitter elements are horizontal, e.g. in ceiling spaces, adequate support and retention of acoustic in-fill must be provided.

The direction of air flow through each attenuator shall be clearly marked on the outer casing.

3.7 COOLING TOWERS

Cooling tower installations shall comply with CIBSE TM: 13 (Minimizing the risk of Legionnaires Disease) and Occupation Health and Safety Requirements.

Cooling towers shall be of the type specified within this Specification and/or the Equipment Schedules. The entering and leaving water temperatures, water flow rate, and ambient wet-bulb design temperature shall be as indicated within this Specification and/or the Equipment Schedules. Tests shall be in accordance with BS 4485: Part 2 and Part 3, as applicable.

All parts of the unit shall be accessible for servicing and cleaning with fixed means of personnel access where specified within this Specification and/or the Equipment Schedules and/or drawings. A suitably sized water supply, terminating in a hose connection, shall be provided locally to units for cleaning purposes.

All necessary joints and bracing in the casing and pond constructions, (including associated jointing components such as nuts, bolts, etc.), shall be made externally such that all internal surfaces are of smooth finish and free from obstructions. There shall be no internal flanges or

ledges, other than those necessary to support packing material or drift eliminators. All nuts, bolts and washers shall have corrosion-resistant finishes. Self-tapping screws will not be accepted.

Casings shall be of steel sheet, glass-reinforced plastics or stainless steel as indicated within this Specification and/or the Equipment Schedules. The casing shall have a treatment to minimise corrosion or decay relevant to the casing material used. Details shall be as indicated within the Specification and/or the associated Equipment Schedule. The casing and structure shall withstand the maximum wind speed of the local environment.

Tower packing and drift eliminators shall be of a plastic material or glass reinforced plastics. Materials shall be resistant to fire, corrosion and deterioration or decomposition due to condenser water treatment chemicals, polluted air and insect attack. Plastic materials shall be self-extinguishing and be resistant to ultra-violet degradation.

Packing material shall not distort in any way under normal use to cause obstruction to air or water flow and shall be resistant to organic growth. Packing shall be designed to ensure that particulate material can drain into the sump for removal. Packing shall be readily cleanable and fitted in sections, each separately supported to facilitate removal.

The water distribution system shall be easily removed and dismantled for cleaning. Where open distribution pans or troughs are used, they shall be fitted with fine mesh grids to exclude debris. Where spray nozzles are used, they shall be of non-ferrous material, easily removable for cleaning and shall be protected by a strainer.

Air inlets and outlets shall be arranged to avoid recycling and shall have mesh grids to prevent ingress of debris. High efficiency drift eliminators shall be provided which limit the drift loss rate to no more than 0.001% of the water circulation rate. These eliminators shall have means of fitting which ensures effective edge sealing to prevent drift by-pass and shall be removable in easily handled sections with air flow direction indelibly marked on each section. The anticipated level of drift shall be as stated within either this Specification and/or associated Equipment Schedules.

Sumps shall be steel sheet hot-dip zinc coated after manufacture, steel sheet anti-corrosion painted, glass reinforced plastics, steel sheet epoxy coated or stainless steel as indicated within this Specification and/or the Equipment Schedules. Sumps shall be designed to collect sludge in such a way that facilitates its removal during cleaning operations. The bottom of the sump shall be sloped towards the drain connection.

The water reservoir shall be shielded from direct sunlight and shall be of sufficient depth above the outlet connection to prevent air entrainment in the outlet pipe during operation. Sump capacity shall be sufficient to prevent overflow when the system shuts down. Sumps shall be fitted with grids of 15mm square mesh to exclude debris from the outlet pipes. An electric immersion heater, controlled by an adjustable thermostat and a low water level cut out float switch, shall be fitted in the water reservoir.

Sumps shall have cold water make-up connection with ball float valve or level control, quick fill provision, overflow connection, drain connection and outlet pipe with removable strainer and anti-vortex plate. The relative positions of the cold water make-up and other pipe connections shall be arranged to avoid creating stagnant water conditions. The drain connection shall be at the lowest point in the sump and shall be of adequate size to facilitate quick draining of the sump. The cooling tower shall be protected against dry run and /or low water condition and provisions shall be made for an audible alarm to be sounded in case of low water in the sump.

Fans shall comply with the Fans Section of this Specification and be of the centrifugal or axial type, particular attention being given to the permitted noise levels indicated within this Specification and/or the Equipment Schedules. Fan casings and impellers shall be made of corrosion-resistant material or be completely proofed against corrosion after manufacture. Fan motors shall be totally enclosed and weatherproofed. Belt or gear drives shall be readily accessible and fully protected against the weather and shall comply with the Drives, Variable Speed Drives and Guards Section of this Specification.

Fan motors mounted in the moist air stream of induced-draught units shall be epoxy coated or have other means of corrosion prevention. Lubrication shall be possible during operation of fans without component removal and without possibility of over lubrication. Fan bearings shall be designed to prevent loss of lubricant and limit the ingress of dirt and moisture.

A bleed pipe, with stop valve and flow regulating device, shall be provided on each unit from the water flow pipe. The bleed pipe shall be connected into the water flow pipe above basin water level and shall be extended to the nearest sump or gully to discharge through an air break.
Cooling water-piping connections shall be flanged to BS 4504 and BS EN 1092-2 or have grooved ends for mechanical joint as indicated within this Specification and/or the Equipment Schedules.

Cleaning and water treatment shall be in accordance with the manufacturers requirements.

Metal parts of cooling towers shall be bonded to earth. Lightning protection shall be provided where indicated within this Specification and/or the Equipment Schedules and/or drawings.

3.8 AIR HANDLING UNITS

3.8.1 GENERAL

'Air Handling Unit' (AHU) shall mean an assembly of packaged plant components. Each component shall be incorporated within a single-skin casing or double-skin casing as indicated within the Equipment Schedules. Casings shall generally be of constant cross-sectional dimensions. Casings shall be complete internal flanged joints. As required within the Equipment Schedules, mixing sections, with fresh and re-circulated air connections complete with dampers as appropriate, and face and bypass dampers shall be included, together with access sections, bulkhead light fittings and viewing panels. Packaged plant components shall comprise a combination of the following: fans, filters, heaters, coolers, humidifiers and attenuators, all as described elsewhere in this Specification. NOTE: Air handling plant components may also be duct-mounted remote from the AHU.

Individual components shall, in addition to the requirements of this section, comply with other relevant sections of this Specification.

3.8.2 CONSTRUCTION

AHUs shall be of rigid construction to minimise distortion and drumming in operation, and shall be no less rigid in construction than the distribution ductwork to which they are connected.

The materials used in the construction of the AHUs shall be corrosion resistant. The jointing methods used in the construction of the AHU, shall ensure that air tightness of the unit are not less than the related ductwork system.

Individual components and sections shall be assembled using proprietary and proven fastening techniques. Locking devices shall be used with all fastenings, which are subject to vibration.

Floor decking, suitable for 1.5kN/m² loading minimum, and shall be provided to all accessible sections.

Each section shall be identified by a clear stencil description on the external surface.

Unless otherwise specified within this Specification or within the Equipment Schedules, there shall be a clearance of at least 150mm between the underside of the AHU and its base or the plant room floor.

Unless otherwise Specification or within the Equipment Schedules, AHUs shall be of double-skin construction incorporating thermal insulation. The thermal insulation shall have a thickness not less than 25mm and a thermal conductivity not greater than 0.03 W/mK. Hollow section frame posts, where used, shall be insulated as for the casing.

Mineral fibre insulation must not be used within the AHU unless factory applied and contained within an impervious membrane designed to last the life of the AHU.
Single-skin units where specifically specified shall be fabricated from galvanised mild steel sheet, or other approved material, in tray form.

Any surface liable to condensation formation shall be insulated and provided with a vapour barrier in accordance with the Thermal Insulation section of this Specification.

Readily removable access panels or hinged doors complying with HVCA Specification DW/144 shall be used. The access panel incorporating air seals shall be provided to facilitate access to upstream and downstream faces and internal parts of all sections in the AHU. Access panels shall be secured with a minimum number of proprietary quick-release captive fastenings consistent with effective air sealing. Hinged doors shall be retained with clamping type latches. Access panels and hinged doors shall be 500mm wide minimum and sized for the full height of the AHU. Self-tapping screws and set screws are not acceptable as panel fastening.

Each removable access panel shall have a double-glazed viewing panel for ease of observation and maintenance. Each section of the AHU requiring access for maintenance/inspection shall be fitted with a bulkhead light. The bulkhead light switch shall be located external to the unit adjacent to the access panel in question.

Sections of packaged AHUs shall be arranged with adequate separation to avoid evaporation of condensate from the cooler by the heater battery and generally to promote even air distribution across the face of all components.

AHUs incorporating humidifying plant and/or cooler batteries, having exposed metal surfaces likely to be affected by moisture, shall be protected by a properly prepared and applied two-coat minimum paint scheme or other approved finish to prevent corrosion. Galvanised mild steel shall be cleaned and painted with two coats of approved bituminous solution or shall receive other such internal treatment as specified within this Specification or the Equipment Schedules. Protection shall extend lm either side of the humidifier or cooler battery. Units shall have corrosion-resistant drain trays of adequate size to collect waste water, extended as necessary or other means of collection provided, to drain away any water deposited or condensed in adjacent sections. Drain trays, pipe work drain connections and traps shall be arranged as described in the Air Heater and Cooler Batteries Section of this Specification. Where the drain tray forms the outer surface of the AHU, the outer surface shall be insulated and vapour sealed.

3.8.3 THERMAL AND ACOUSTIC INSULATION

Thermal insulation shall be securely fixed to all sections handling heated or cooled air and a vapour barrier shall be provided as appropriate. Thermal and acoustic insulation shall be in accordance with the Thermal Insulation section, and the Vibration Isolation and Noise Isolation, section of this Specification. Where free moisture may be present, a waterproof membrane shall be provided. Protection shall be provided to avoid damage to insulation in sections having walk-in access. For single-skin units, thermal insulation shall be closed-cell type and have a thickness not less than 25mm and a thermal conductivity less than 0.03 W/m K.

3.8.4 FANS

This section of the specification shall be read in conjunction with the Fan section of this Specification. Each fan shall be selected to provide the duty as specified within the Equipment Schedules.

AHU fans shall comply with the requirements of the Fans section of this Specification. Additionally, the fan section shall be tested in accordance with BS 6583 and fan total efficiencies shall be not less than 60% and 50% for backward bladed and forward curved types respectively.

Unless otherwise specified within this Specification or the Equipment Schedules, each fan and drive motor shall be mounted on a common frame or other means of support. The complete assembly shall be isolated from the casing to prevent the transmission of vibration. Electrical connections shall not inhibit free movement of the fan and drive motor set.

Where the fan and drive motor are directly connected to the fan section casing, the casing shall be isolated from the structure to prevent transmission of vibration. Flexible jointing to adjacent sections shall be provided.

Where an externally mounted drive motor is specified within the Equipment Schedules, the fan impeller shaft shall extend through an airtight gland seal in the casing. Flexible joints shall be in accordance with the Ductwork, Dampers and Terminal Devices section of this Specification. Vibration isolators shall be in accordance with the Vibration Isolation and Noise Insulation section of this Specification. Both sections of the specification shall be used to minimise the transmission of vibration and noise from the air-handling unit.

All power transmission shafts, belts and pulley drives shall be guarded in accordance with the Belt Drives and Guards section of this Specification.

3.8.5 AUTOMATIC CONTROLS, SENSORS, INSTRUMENTS & TEST HOLES PROVISIONS

Airtight sleeves shall be provided for control sensors, instruments and test holes for the following applications:

a) Double-skin units,
b) Insulated single-skin units,
c) Ducts insulated internally or externally.

Components housing control elements shall comply with:

a) The panel enclosure shall be rigidly constructed from suitably prepared and finished best quality folded mild steel sheet of a minimum thickness 2mm or of mild steel angle frame supporting sheets of mild steel of a minimum thickness 1.25mm, or be a proprietary system of construction to the approval of the Engineer;
b) Purpose-made panels shall comply with the requirements for assemblies contained in BS EN 60439-1;
c) Normal service conditions for panels shall be as stated in BS EN 60439-1, unless otherwise specified within this Specification or the Equipment Schedules. All items of equipment mounted on or within the panels shall be rated for these service conditions;
d) Electrical compartments and compartments housing control elements in air handling units, shall be designed to exclude damp and dust and shall be provided with an anti-condensation heater controlled by an ambient air thermostat with adjustable set point.

3.8.6 OUTDOOR UNITS

Air-handling units for outdoor installation shall have a weatherproof outer casing, a pitched roof constructed of watertight metal decking with water seals in all joints and lockable access doors.

Bulkhead light fittings shall be provided in each section with a weatherproof external switch and all wiring in galvanised mild steel conduit.

Thermal insulation shall be in accordance with the Thermal Insulation section of this Specification.

Each removable access panel shall have a double-glazed viewing panel for ease of observation and maintenance. Each section of the AHU requiring access for maintenance/inspection shall be fitted with a double-glazed viewing panel and bulkhead light. The bulkhead light switch shall be located external to the unit of a suitable IP rating, adjacent to the access panel in question.

3.9 AIR FILTERS

3.9.1 GENERAL

Filter assemblies shall operate with not less than the efficiencies or values of arrestance specified for individual cells. Filter material or wetting agents shall not be carried over in the air stream. Adequate access shall be provided for removal and refitting of filter cells and replacement of gaskets in filter holding frames.

Unless otherwise indicated within this Specification and/or the Equipment Schedules, filters arranged for side withdrawal shall not be used.

Filter differential pressure indication shall be provided for each filter assembly. The individual filter differential pressure shall be provided via an inclined manometer unless specifically advised otherwise. The inclined manometer shall have a graduated scale incorporated, on which the indication of maximum pressure differential shall be at no more than 75% of full scale. The initial resistance and final resistance of the filter shall be indelibly marked on or adjacent to the instrument.

3.9.2 FILTER CELL HOLDING FRAMES, SEALS AND GASKETS

Filter cell holding frames shall be purpose made from non-ferrous, metal, plastic, or steel protected against corrosion, of adequate strength and stiffened as required to prevent distortion in use.

Holding-down frames shall be capable of retaining air filters, constructed within the dimensional tolerances stated, in a rigid manner and without edge leakage.

The entire framework shall be securely fixed in position with all edges and joints effectively sealed to prevent air leakage.

Purpose-made gaskets shall be provided to minimise air leakage around the filters. The effectiveness of the seal shall not be impaired by removal and refitting of filter cells. Gasket material shall be fitted in the holding frames except in the case of holding frames for HEPA.

The retaining clips, or other securing device, shall be capable of pulling the filter on to its seating and shall exert equal pressure on all faces.

For HEPA type filters in side withdrawal frames, retention shall be by over-centre cam operation with pressure adjustment. Holding-down bolts are acceptable where adequate access is provided.

3.9.3 FIRE PROPERTIES

Filter media (other than for adsorption filters), all materials of construction, adhesives, coatings and wetting agents shall permanently retain self-extinguishing properties.

When exposed to heat or flame, the filter shall not generate significant quantities of smoke or toxic fumes into the air stream. In no case shall the total toxic vapour emission into the air stream, calculated over a period of 10 minutes, result in the 10 minute exposure level of any toxic constituent given in the occupational and safety requirements and or the factories act be exceeded.

Where flameproof filters are indicated either within the Equipment Schedules or elsewhere within this Specification, the frames, casings and filter cell holding frames shall be classified non-combustible when tested in accordance with BS 476:1987: Part 4.

3.9.4 PERFORMANCE CERTIFICATION

A copy of the type test certificate, issued by an accredited air filter testing laboratory shall be submitted for each type of filter offered.

Filters of the extended surface type and panel type shall be tested in accordance with BS EN 779. The certificate shall indicate the results of a test conducted on filters with a nominal face area 600mm x 600mm and at a face velocity of 2.5m/s or 1.75m/s as required under the relevant clauses of this Specification.

Filters with an initial atmospheric dust spot efficiency exceeding 98% are not covered by BS EN 779. If initial atmospheric dust spot efficiency is less than 20%, filter is classified as a group G filter.

HEPA filters shall be tested in accordance with BS 3928:1969.

a) For filters of 99% efficiency and above, each filter shall be individually tested.
b) Random tests for filters below 99% efficiency will be accepted. A minimum sample of 10% (minimum one filter), of each size and efficiency shall be tested.

Test certificates for all units shall be submitted to the Engineer.

At the discretion of the Engineer, two samples of any filter intended for use shall be selected by him at random for test to the standards specified.

3.9.5 FILTER GRADES

Where filters are specified in terms of a Filter Class, this relates to average atmospheric dust spot efficiency or average synthetic dust weight arrestance in accordance with BS EN 779. The grade for any particular class of filter applies to air volume, dust holding capacity and final resistance as stated in Table 2A.

3.9.6 BAG OR EXTENDED SURFACE TYPE FILTERS

Air velocity at the filter face shall not exceed 2.5m/s. Filters shall be fully self-supporting without external ties or stiffening frames. Filters shall inflate fully, shall not sag or flutter, nor have effective medium area reduced by obstruction due to contact with other filter faces or housing surfaces when operating between 60% and 110% of design air volume flow rate for fixed volume systems.

The following face dimensions shall apply:

595 ± 3mm high x 595 ± 3mm wide
595 ± 3mm high x 493 ± 3mm wide
595 ± 3mm high x 290 ± 3mrn wide
290 ± 3mm high x 595 ± 3mm wide
290 ± 3mm high x 290 ± 3mm wide
Front flange of filter shall be 21 ± 2mm thickness.
Filter length shall not exceed 760mm.

The dust holding capacity, as achieved by tests carried out on 595mm x 595mm air filters at an air volume flow rate of 0.94m3/s, shall comply with the following:

Class 3 filters; Not less than 500g at 250 Pa final resistance
Class 4 filters; Not less than 450g at 250 Pa final resistance
Class 5 filters; Not less than 450g at 250 Pa final resistance
Class 6 filters; Not less than 550g at 350 Pa final resistance
Class 7 filters; Not less than 450g at 350 Pa final resistance
Class 8 filters; Not less than 350g at 350 Pa final resistance

Unless otherwise indicated within this Specification and/or Equipment Schedules, pre-filters of this type shall conform to Class 3 and main filters to Class 5.

A set of spare filters shall be provided to completely replace each filter assembly and shall not be fitted without the prior approval of the Engineer.

3.9.7 PANEL FILTERS

Air velocity at the filter face shall not exceed 1.75m/s. Cardboard filter casings shall be treated for use in conditions up to 80% saturation and shall be adequately stiffened to prevent distortion in handling.

Where filter pads in permanent casings or frames are provided, the pads shall be limited to the requirements for Grade 2 filters. Pads shall comply with all requirements for replaceable type panel filters. Frames shall conform to the dimensions the following face dimensions:

Class 2 and Class 3 filters;

595 ± 3mm x 595 ± 3mm
595 ± 3mm x 493 ± 3mm
595 ± 3mm x 290 ± 3mm
493 ± 3mm x 493 ± 3mm
Depth of filter shall be 48 ± 2mm.

Class 4 filters;

595 ± 3mm x 595 ± 3mm
Depth of filter shall be 97 ± 2mm.

The dust holding capacity, as achieved by tests carried out on 595mm x 595mm air filters at a face velocity of 1.75 m/s, shall comply with the following:

Class 2 filters: Not less than 275g at 170 Pa final resistance
Class 3 filters: Not less than 250g at 170 Pa final resistance
Class 4 filters: Not less than 300g at 250 Pa final resistance.

The filters shall conform to the classes as indicated above.

A set of spare filters shall be provided to completely replace each filter assembly and shall not be fitted without the prior approval of the Engineer.

3.9.8 HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTERS

HEPA filters and filters of HEPA type construction shall consist of pleated glass paper or other approved medium sealed within a rigidly constructed case.

The air filter casing filter medium, protective cappings and sealing gaskets shall be of materials compatible with the temperature, humidity or corrosive conditions specified within this Specification and/or Equipment Schedules. The casing shall not warp, splinter or corrode.

Unless otherwise specified within this Specification and/or Equipment Schedules, a 6mm thick gasket shall be fitted to the downstream face of the filter. The gasket shall be of one-piece moulded construction or with all joints sealed to ensure a positive air seal through the filter life.

Before any filter is fitted into its holding frame, the gasket shall be lubricated to prevent subsequent adhesion to its mating face. The lubricant shall be compatible with the gasket and mating face materials.

Test groove seals shall be incorporated where specified elsewhere within this Specification and/or Equipment Schedules.

Where specified within this Specification and/or Equipment Schedules, completed installations using HEPA filters shall be tested as part of final commissioning. The test shall be carried out by a competent specialist, acting for the Contractor, approved by the Engineer. The test shall be conducted using DOP, sodium flame or other method approved by the Engineer. During the entire test period, design airflow rate conditions shall be maintained to within the specified limits. On completion of satisfactory testing, a test certificate shall be issued.

3.9.9 GREASE ELIMINATORS

Grease eliminators shall be of the corrugated plate type, crimped wire mesh type or baffle type and be entirely of metal. All materials used shall be resistant to or protected against corrosion. Where grease eliminators are fitted in kitchen hoods, the assembly shall include a drip tray and the element shall be secured in the frame by quick-release clips.

In all cases the grease eliminator shall be readily accessible and removable for cleaning.

3.10 UNITARY REVERSE CYCLE HEAT PUMPS

Reverse cycle units shall include the following main components: - compressor, centrifugal fan, refrigerant flow reversing valve, capillary expansion valve, refrigerant /room air heat exchanger, refrigerant /water heat exchanger and air filter. Water heat exchangers to be connected to common water circuit supplying or absorbing heat from units on heating or cooling cycle. The refrigeration installation shall comply with BS 4434. The unit shall have a protection mechanism that shall isolate the compressor from electrical power should the water in the water / refrigerant heat exchanger exceed 40 ^{o}C.

All items shall be mounted on a common framework with access for inspection service and maintenance.

Units shall be of robust construction and sufficiently rigid to operate under all service conditions without drumming or vibration. Leakage is not acceptable under any operating conditions.

Each unit shall be complete with initial charge of refrigerant and lubricating oil and prepared ends flexible pipe connections.

The unit-operating mode shall be automatically controlled by a thermostat, with manual adjustment, either in the unit or remotely mounted.

Tests shall be made in accordance with accepted Standards and Codes of Practice.

The noise level in rooms, with each unit operating at its normal speed shall not exceed the noise rating (NR) indicated within the Equipment Schedules. Acoustic data shall be provided including octave band analysis of the sound power level under free field conditions.

Anti-vibration mountings shall be in accordance with the Vibration Isolation and Noise Insulation Section of this Specification.

3.11 FAN COIL UNITS

3.11.1 GENERAL

Fan coil units shall comprise a frame housing a fan set with anti-vibration mountings and cooling and/or heating coil with control valve and drain tray. The following items shall also be included:

a) Fresh air spigot where indicated within this Specification and/or the Equipment Schedules, and/or the drawings
b) Air filter,
c) Re-circulation air spigot and grille,
d) Supply air grille with two sets of adjustable blades,
e) Thermal insulation and acoustic lining,
f) Casing, with access panels as indicated within this Specification and/or the Equipment Schedules,
g) Additional ducting where indicated within this Specification and/or the Equipment Schedules, and/or the drawings,
h) Mounting or suspension provisions.

All components shall comply with the appropriate sections of this Specification except that:

a) Fans, which shall be easily removable from the unit, may be of the forward curved centrifugal or tangential flow types and may be of mild steel, aluminium, reinforced glass fibre or rigid plastic material.
b) Air filters may be of nylon fibre, glass fibre or cellular plastic materials and shall be Grade 3 when tested in accordance with BS EN 779.
c) Unless otherwise indicated within this Specification and/or the Equipment Schedules, cooling coils and heating coils shall be formed of copper tubes with aluminium fins. Aluminium fins for cooling application shall be complete with anti-corrosion protection.

The volumetric and thermal performance of fan coil units shall meet the requirements indicated within the Equipment Schedules and comply with the Thermal Insulation Section, and the Vibration Isolation and Noise Insulation Section, of this Specification. Testing and rating shall be in accordance with BS 4856: Parts 1 to 4 inclusive, as applicable to suit the particular arrangements.

The noise level in the space, with each unit operating at its normal speed, shall not exceed the noise rating (NR) indicated within this Specification and/or the Equipment Schedules. Acoustic data shall be provided including octave band analysis of the sound power level of the unit produced at each available unit speed under free-field conditions.

3.11.2 CASINGS

Unless otherwise indicated within this Specification and/or the Equipment Schedules, casings shall be provided as part of the unit. Casings shall include space for pipe work connections and valves with ready access to the fan and motor, filter, damper, drain tray, pipe work connections, valves and controls.

Casing shall be corrosion resistant and of rigid construction. Alternatively, if of steel sheet, treatment to prevent corrosion shall be applied internally and externally. All corners shall be free of sharp edges.

Account shall be taken of requirements to enclose units within builders work casings or for special finishes as indicated within this Specification and/or the Equipment Schedules, and/or the drawings.

3.11.3 COMPONENTS

Cooling coils shall be two rows minimum depth and shall include an air vent. Cooling coil drain trays shall be provided and be extended to beneath the control valve assembly. The bottoms of casings shall be made in the form of a watertight drain tray from steel sheet galvanised after manufacture, or be otherwise equally corrosion resistant. The drain tray serving the cooler shall be extended or a separate tray shall be provided to collect water. Drain trays shall be sloped towards a flush drain connection so that no water is retained in the drain tray. A pipe work drain connection, complete with quick-release refillable trap, shall be extended from the lowest point on the underside of the tray to the nearest sump or gully to discharge through an air break. A water seal of sufficient depth shall be provided to prevent entry or exit of air to or from the system and additionally maintain a 75 mm seal when the plant is de-energised. The distance between the underside of the tray and the crown of its trap is to be sufficient to ensure the tray is fully drained during operating periods. Drainage pipes shall discharge at the positions indicated on the drawings.

Unit fans shall be rated for the resistance of the external ductwork as specified within the Equipment Schedules.

3.12 WATER PUMPS

3.12.1 GENERAL

Values of resistance to fluid flow of items of equipment, pipe work and /or the total distribution system are indicated for tender purposes only. The Contractor shall obtain and use manufacturers' certified values of resistance to fluid flow of all equipment items and fittings, which comprise the total distribution system indicated on the drawings. The pumps provide shall be capable of delivering the required volume when operating against the total resistance calculated from this data and the pipe work resistance. Changes in system arrangement or pipe sizes shall also be compensated for. Where appropriate pumps shall include for available net positive suction head (BS 5316: Part 1) and for static lift, e.g. for condenser cooling water pumps at cooling towers.

Pumps shall be installed in accordance with the manufacturer's recommendations and shall comply with the requirements of BS EN 60335-2-51, BS 4082: Part 1 and Part 2, and BS 5257 as applicable.

Pumps shall be 'type' tested in accordance with the requirements of BS 5316 Part 1 and shall be selected to give the correct fluid flow rate. Pump curves and test certificates shall be submitted to indicate performance under all likely operating conditions.

Unless otherwise indicated pumps and their drives shall be segregated such that failure of pump seals shall not result in damage to drive motors.

Floor mounted pumps shall be set on a prepared base not less than 100mm high incorporating anti-vibration inserts and foundation bolt pockets constructed by the Building Contractor to information provided by the Contractor in accordance with the Vibration Isolation and Noise Insulation Section of this Specification. Pumps shall be properly leveled and aligned before final fixing down.

Pump connections shall be screwed to BS 21 for sizes up to 50mm and flanged to BS 4504 and BS EN 1092-2 to suit the system maximum pressure on sizes 65mm and above.

Connecting pipe work shall be arranged to ensure that no stresses are transmitted to pump casings.

All pumps except draining pumps shall be installed with an isolating valve on suction and delivery connections.

Pumps shall be complete with a drain plug and, except where the pump is inherently self-venting, an air release cock.

Unless otherwise indicated, pump shaft speed shall not exceed 24 rev/s.

Pumps shall be provided with anti-vibration mountings and flexible connections where indicated.

The Contractor shall be responsible for providing all dimensions and details to enable pump bases to be set out

3.12.2 CENTRIFUGAL PUMPS

Horizontal or vertical circulators shall be electrically driven and of the following types:

a) Centrifugal type, close coupled, or with direct or approved indirect drive and taper connections where necessary on suction and delivery ports. Direct drive pumps and motors shall be mounted on a common bed plate.
b) In-line pumps with connections of a different size to the main pipe work may be used subject to the approval of the Engineer. Eccentric reducers shall be correctly fitted at suction and delivery ports.
c) For LTHW systems only, purpose designed pumps of the 'canned rotor' or similar glandless type may be used.
d) For DHWS systems, pumps shall be as described for LTHW systems immediately above but shall have body castings of gunmetal.

Pumps shall comply with BS 4082 or BS 5257 as appropriate. Shafts and impellers shall be corrosion resistant. Shaft extensions shall have a liquid shield. Cast iron casings shall not be subjected to a pressure in excess of 15 bar gauge. Impellers shall be balanced to Balance Quality Grade G6.3 of BS 6861: Part 1.

Pumps installations shall include suction and discharge taper pieces where necessary. Shafts shall be corrosion resistant. Shaft seals shall be dripless mechanical or packed gland type as indicated within this Specification and/or the Equipment Schedules. Pumps with packed glands shall have shafts hardened as necessary. Where a lantern ring is fitted it shall be non-metallic. Gland packing material and construction shall be suitable for the operating conditions and shall be approved by the Engineer. Packed glands shall be provided with separate drip pipes, run to discharge visibly over a tundish or water drainage gulley.

Bearings shall be either sleeve type with oiling ring and reservoir, or ball or roller type with grease lubricator or sealed for life. The bearings shall be outside the stuffing box and shaft seal.

Unit-constructed close-coupled pumps shall be of the back pullout type, enabling the motor, drive and impeller to be withdrawn from service without disturbing the volute casing, connections, piping, etc.

Direct-driven pumps and their drive motors shall be mounted on a common bedplate.
In-line pumps shall be fitted with mechanical seals unless otherwise indicated. Eccentric reducers or taper pieces shall be fitted at suction and discharge connections where pump connection sizes differ from pipeline size. Pumps shall be suitable for mounting on a prepared base with foundation bolts or on wall brackets.

Each circulating pump shall be installed with a valve on the inlet and a valve on the outlet connections.

Each floor-mounted circulating set shall be properly levelled, bolted down and grouted-in, on a brick or concrete base provided by the Building Contractor to details supplied by the Contractor. Base height to the underside of the pump shall be 300mm minimum. Anti-vibration mountings and flexible connections shall be provided as indicated. The Contractor shall ensure that the complete unit is effectively balanced to eliminate noise and vibration. Belts, where fitted, shall be correctly aligned and tensioned.

3.12.3 TWIN PUMP SETS

Twin pump sets shall comprise direct coupled in-line pumps connected in parallel with common inlet and outlet connections. The assembly shall incorporate non-return check valves to isolate the stationary pump. Twin pump sets shall be suitable for mounting on a prepared base with foundation bolts or on wall brackets. Impeller and motor assemblies shall be readily removable and a blanking flange shall be provided.

3.12.4 CANNED ROTOR PUMPS

Canned rotor and glandless pumps up to 2kW input power shall comply with BS EN 60335-2-51 and BS 1394: Part 2.

3.12.5 STAND-BY PUMPS

Where stand-by pumps are indicated with automatic changeover, the changeover shall be initiated and verified by means of flow sensing devices of an approved pattern. Non-return check valves shall be incorporated in each discharge line.

3.12.6 GAUGES

Each pump shall be provided with two pressure gauges, one connected to the suction side and one to the discharge side of the circulator. Where stand-by pumps are installed, one pair of gauges shall be so connected with isolating cocks to the common suction and delivery mains that the pressure head of each pump can be read. The gauges shall be provided with air venting facilities, flanged backs, and shall be mounted at the same horizontal level. In all other respects they shall be in accordance with:

a) Pressure gauges shall comply with BS 1780 with Class I industrial scales. Where requested by the Engineer, the Contractor shall demonstrate the accuracy of the gauges to the requirements of the BS.
b) Pressure gauges fitted to plant or pipe work associated with LTHW, chilled and condenser water systems shall have dials calibrated in bar from zero to not less than 1.3 times and not more than twice the operating pressure. Where fitted on pressure vessels and boilers, the gauges shall be as required by BS 759: Part 1 with dials not less than 150mm diameter and with cases of enamelled steel. Where fitted elsewhere, the dials of gauges shall be not less than 100mm diameter and the cases shall be of enamelled steel or moulded plastics. Pressure gauges shall be fitted with lever handle cocks and, where appropriate, syphon pipes. Pressure gauges shall be of matching finish to dial type thermometers.

c) Pressure gauges used solely to indicate the altitude or head and pressure of water shall have dials calibrated in bar and metres head. Other gauges shall be calibrated in bar and/or kPa to suit the application. In addition to the indicating black pointer, gauges shall be provided with an adjustable 'tamper-proof red pointer' set to indicate the normal working pressure or head of the system.

3.12.7 SUMP PUMPS

A removable non-ferrous strainer on the suction shall protect each pump. Suction lift pumps shall terminate with a foot valve of diameter not less than the pipe work. Sump pumps shall operate automatically under level control with provision for an alarm to indicate when normal high water level is exceeded.

Submersible and submerged pumps shall be complete with high and low level controllers, control panel, lifting handle and chain and guide rails as necessary. Studs, bolts, nuts, screws and washers shall be stainless steel.

3.13 ANCILLARY EQUIPMENT

3.13.1 Pipe Work Supports

Pipe work shall be supported adequately in such a manner as to permit free movement due to thermal expansion and contraction. Pipe work supports shall be arranged as near as possible to joints, and the centre spacing shall not exceed those given in tables below. Where pipes are thermally insulated the insulation shall be carried through the support. Where there are two or more sizes of pipes, the common support spacing shall be those required by the smallest bore pipe work. Supports for natural gas pipe work shall comply with the requirements of IGE Utilization Procedures IGE/UPI2. The weight, method of supporting pipe work, together with the thrust at anchor points is to be approved by the Engineer

Plastic pipe work shall be continuously supported as far as possible. Where this is impracticable the spacing of the supports shall not exceed those in the Table below or as indicated in the appropriate tables in BS CP 312: Parts 2 and 3.

Pipe Nominal Bore (mm)	Horizontal Rums (m)			
	Iron	Copper	uPVC	PPR
15	1.80	1.20	0.30	0.70
20	2.40	1.80	0.35	0.75
32	2.40	1.80	0.38	0.85
40	2.75	2.40	0.43	1.10
50	3.00	2.40	0.45	1.25
65	3.65	3.00	0.65	1.35
80	4.00	3.00	0.67	1.55
100	4.00	3.00	0.75	1.70
150	4.00	3.00	1.00	2.00

NB: *The support spacing for vertical runs shall not exceed one and a half times the distances given for the horizontal runs.*

Vertical rising piping shall be supported at the base, or as indicated either within this Specification and/or the drawings, to accept the total weight of the riser. Branches from vertical pipe work shall not be used as a means of support for risers.

Brackets for mild steel pipe work shall be mild steel or malleable iron with ferrous fixings. Brackets for copper pipe work shall be brass or gunmetal with non-ferrous fixings.

Where pipe work up to DN 50 is fixed to solid walls, brackets may be of the screw-on or long shank built-in type, except where the walls are plastered, where only the long shank built-in type shall be used. For fixing to woodwork and lightweight partitions or walls, brackets shall be screw-on pattern and adjustable two-piece type are acceptable. The detachable part of a pipe clip shall be capable of removal without disturbance of the fixing or adjacent pipes. Allowance shall be made in the support for the thickness of thermal insulation where required. Cast-iron and steel spigot and socket pipe work shall be supported at each joint on mild steel angle or tee brackets embedded not less than 115mm into walls. Pipe work shall be secured to the brackets by 'U' bolts or mild steel stirrup bolts.

Brackets screwed to walls shall be secured by expanding plugs or other purpose-designed fixing devices. Wooden plugs will not be permitted.

Pipe work subject to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise approved.

Hangers for horizontal pipe work at high level shall be adjustable mild steel supported from mild steel angle or channel sections, supplied by the Contractor, suitable for building-in or otherwise securing to the structure by the Building Contractor. Welding to the structure shall not be undertaken without the prior approval of the Engineer. Adjustable mild steel hangers shall be used. Pipe rings shall be of malleable cast-iron or fabricated steel, made in halves and secured by bolts or screws. Alternatively, malleable iron hinged pipe rings may be used. Calliper hooks will not be accepted. Proprietary pipe work suspension systems may be used with the approval of the Engineer.

Where pipe work is fitted in ducts or trenches, or where DN65 or greater, the pipe supports shall be of the type indicated within this Specification and/or on the drawings. Where appropriate, allowance shall be made for clearance to permit thermal insulation to be applied to the requirements of the Thermal Insulation Section of this Specification.

Load bearing insulation at supports incorporating a vapour barrier, shall be fitted by the Contractor at the time of pipe work installation to ensure continuity of the overall vapour barrier. The insulation supports shall comply with:

a) Insulation shall be continuous through supports, where the material used shall be capable of supporting the imposed load. Where pipe movement is facilitated by rollers or similar devices, the load bearing insulation shall extend beyond the limits of pipe movement.
b) The preformed insulation outside surfaces shall be smooth, unbroken, uniform and firm. Outer coverings shall be continuous through support joints.

3.13.2 Anchors

On mild steel pipe work, mild steel anchors capable of resisting the maximum stresses shall be provided and preferably shall be welded to the pipe work. Where it is impracticable to weld the anchors to the pipe work, cast-iron chairs with at least two wrought-iron stirrup bolts shall be used, the bolts being provided with sufficient thread to ensure an effective grip on the pipe. For copper pipe work, the anchors shall be provided by wide copper straps secured to the pipe work in such a manner that the pipe is not damaged. The Contractor shall supply, and locate in positions for building-in, all cleats, brackets and steelwork required for anchor points.
Steelwork fixed in trenches or ducts to which anchors are attached shall be hot-dip galvanised. Anchors attached to pipe work shall be cleaned and finished with two coats of aluminium paint.

3.13.3 Expansion Devices

Provision for movement due to thermal expansion and contraction shall be made by changes in direction of the pipe work, by loops or by special expansion joints approved by the Engineer. Measures shall be taken to prevent the movement of pipe work causing damage to thermal insulation. Supports and guides shall be arranged to ensure that movement is taken up as intended. Where pipe work is required to be pre-stressed, the extent of the cold pull shall be as indicated either within the Specification and/or drawings. Fixing bolts for flanged joints shall not be used for taking up cold pull allowance.

Expansion joints may be of the articulated or axial type as indicated within the Specification and/or the drawings and/or Equipment Schedules, and have screwed or flanged ends as appropriate. Internal liners shall be incorporated if required, manufactured from corrosion-resistant steel, or other approved material appropriate to the duty, and designed to withstand the test pressure of the system. Expansion joints shall be capable of not less than 2000 complete cycles of movement over the designed working range.

Expansion joints for angular movements shall be provided with tie rods or hinges to take end thrust, and shall comply in general with this section of the specifications.

Expansion joints shall be provided with external protection against damage where indicated within this Specification, Equipment Schedules and/or on the drawings. The method of protection shall be approved by the Engineer.
Expansion joints shall be installed so that they are not subjected to stresses other than those for which designed. Installation shall ensure joints are in the free position at a temperature midway between the high and low limits of normal service.

Expansion joints shall have guides to ensure that all movements are taken up in the designed manner. Expansion joints shall be installed in accordance with the manufacturer's recommendations. On completion of installation and before heat is applied to the system, the Contractor shall obtain certification that the installation is in accordance with the manufacturers' instructions. Guides shall be rigidly secured and allow freedom of movement for pipe expansion without excessive clearance. Lubrication points shall be provided where necessary.

3.13.4 Air vents

Devices for air venting shall be provided at the high points of the sections, which they are, intended to vent.
Air bottles shall be of welded construction. On chilled and condenser water pipe work up to and including DN 80 size, each bottle shall be manufactured from DN 50 size tube 300mm long with a cap. Air bottles on pipe work DN 100 size and over shall be manufactured from DN 100 size tube, each 380mm long with a cap, directly connected to the system pipe work. All air bottles shall be complete with a DN 15 size galvanised air release tube extended from the top to a position approved by the Engineer within 1.5m of the floor and fitted with a DN 10 size needle-seated globe valve or air cock.

Air bottles for LTHW systems shall be made from DN50 tube approximately 230mm long fitted with a cap and size 3/8 air cock. They shall be fitted to equal tees or have DN50 connections if the main is larger than DN50. Where an air bottle is fixed out of reach a DN10 extension tube shall be run from the cap to within 1.5m of the floor, terminating with a size 3/8 needle-seated globe valve or air cock.

Automatic air vents suitable for the system temperature and pressure shall be used only where indicated on the drawings, and have malleable iron, nodular iron, gunmetal or brass bodies as indicated within this Specification and/or drawings. They shall have non-ferrous or stainless steel floats, guides, non-corrodible valves, and seats. Each automatic air vent shall be controlled by a lock-shield valve. Air release pipes shall be run to discharge at the nearest suitable visible safe point to the approval of the Engineer.

Air venting devices and any air release pipes installed in exposed positions where freezing is likely to occur, shall be insulated.

3.13.5 DRAINING AND FLUSHING PROVISIONS

Key operated drain cocks, of the size indicated on the drawings with hose unions shall be fitted to the lowest accessible points of the system pipe work and on individual items of plant to ensure complete drainage. Where pipes run under doorways and for similar short sections of pipe work which do not drain to the system low points, DN 15 size plugged-outlet tees shall be supplied and fitted.

Steel pipe work from drain valves or cocks shall be galvanised.

Drain valves or cocks shall be lockable except where prohibited by the Water Company.

Provision shall be made to permit the pre-commissioning cleaning and flushing of pipe work. These provisions shall include:

a) Self-draining section: The pipe work systems shall be sub-divided into self-draining sections. Such sections shall be fitted with drains of the straight-through type, e.g. quarter-turn plug cocks, ball valves, butterfly or gate valves of line size up to DN 40 diameter, and DN 50 minimum for all larger pipe sizes. Full-bore dirt pockets at least 5 diameters in length, complete with full-bore isolating valves, shall be provided at the base of each riser. Each dirt pocket shall have a drain valve of at least DN 25 size.
b) Air vents: Manual air vents of minimum size DN 25 connected to large-bore air bottles, shall be installed at high level on each self-draining section.
c) By-passes: Provision shall be made for flexible or fixed full-bore by-passes to be fitted across all major items of plant in order to facilitate the circulation of water during dynamic flushing operations.
d) For pipe work sizes exceeding 200mm, provision shall be made, where indicated on the drawings, for flexible or rigid lance water jetting. Flanged make-up tee pieces (minimum one) three pipe diameters in length, to facilitate entry into the system, shall be fitted at intervals not exceeding 100m.
e) Items which could be damaged by the flushing and cleaning process shall be isolated and cleaned by approved alternative methods.
f) In systems, where pipe work sizes are DN40 to DN200 inclusive (other than those in which boiler, chiller or cooling tower flow and return headers are fitted with spare blanked connections). A flushing connection shall be fitted to the common flow and return to/from the boiler(s), chiller(s) and/or cooling tower(s). These connections shall be of the same size as the largest pipe size of any sub-circuit. Additionally, at intervals not exceeding 100m, an isolating valve immediately preceded by a drain valve, shall be included in all the circuit pipe work. The drain valves shall be of the straight through lockable type and shall be line size for pipe work up to DN40 and DN50 otherwise.

On completion of pre-commissioning cleaning, and before final filling, the flushing connections shall be finally closed with bolted blank flanges and the drain valves locked in the closed position.

In addition to the requirements of emptying purposes, 15mm minimum size drain cocks or valves, with hose connections, shall be fitted at all low points of each water systems.

Where a pipe dips under a door into an accessible floor chase, a 15mm plugged outlet shall be fitted to all water systems.

3.14 REFRIGERATION

Mechanical vapour compression refrigeration plant shall use hydrogenated CFCs (HCFC) or hydrofluorocarbons (HFC) or other refrigerant having zero Ozone Depletion Potential (ODP) approved by the Engineer. The plant shall include all accessories necessary to ensure continuous and reliable automatic operation. The design maximum cooling rate shall be achieved at the maximum ambient conditions indicated within this Specification and/or the Equipment Schedules. Each unit shall be capable of running continuously at the lowest step of cooling capacity without any adverse effect. The plant shall be charged with lubricant, and be provided with a holding charge of refrigerant or inert gas before dispatch from the Works where a full charge is impractical.

Installations shall comply with BS 4434, 'The Safety Code for Refrigerating Systems Utilising Chlorofluorocarbons-Part 1' published by the Institute of Refrigeration, and CECOMAF Document GT1-001.

Refrigerants R11, R12 and R22 shall not be offered for any new cooling plant installations.

Any refrigerant used shall be fully compatible with all materials comprising the complete refrigeration system.

Rating tables physical data and capacity curves relevant to the selection of the equipment shall be available for a range of operating conditions and be based on manufacturer's test results. Pressure drop values for water-cooled condensers and evaporators shall be determined from test results and shall be to be verified. Fouling factors shall be stated in the Equipment Schedules.

Major components shall be readily accessible for maintenance and arranged to facilitate removal without disturbing other system components.

Semi-hermetic and hermetic compressors will only be acceptable on complete factory assembled refrigeration systems, condensing units or chiller compressor sets provided the units are:

a) Fully charged at manufacturer's works, or
b) Complete with holding charge of refrigerant or inert gas on arrival at site.

Open type compressors shall have a replaceable rotary mechanical seal fitted to the driving shaft, which prevents leakage of refrigerant and oil. For direct-coupled type units of input power greater than 25kW, flexible drive couplings shall be of a type which enables the shaft seal to be removed without moving the compressor or motor.

All parts of refrigerant gas cooled motors shall be proof against long-term contact with refrigerants and compressor lubricating oil.

The motor of a compressor which is refrigerant gas cooled shall have in-built protection against inadequate cooling.

The oil pump of three-phase semi-hermetic and hermetic compressors shall either operate equally well under each direction of rotation or have special arrangements made to prevent reverse rotation.

A resiliently mounted control centre on or close to the refrigeration unit shall house the control and protection equipment.

Visual indication of operation of all safety protection devices shall be provided.

Where indicated within this Specification and/or the Equipment Schedules, provision shall be made for remote indication of each alarm condition and for remote indication of all outputs to a building management system (BMS) or other control system.

Hours-run meters shall be provided to all compressors in excess of 6kW input power.

The noise level in the space, from each unit operating at its design duty, shall not exceed NR90. Acoustic data shall be provided including octave band analysis of the sound power level of the unit under free-field conditions.

3.14.1 RECIPROCATING COMPRESSORS

Main rotating and reciprocating components shall be statically and dynamically balanced. Crankshafts and eccentric shafts of all open or semi- hermetic compressors having an input power to the compressor in excess of 2.25 kW shall run in replaceable

bearings.

Pistons greater than 50mm diameter shall be fitted with either:

a) Two compression rings and one oil control ring, or
b) A combination of compression ring(s) and a piston specially shaped to act as an oil scraper.

All open and semi-hermetic compressors having an input power to the compressor in excess of the following shall have:

a) Removable cylinder liners (50kW compressor input power and above only).
b) Side and/or end covers which will enable servicing or repair of the unit to be carried out 'in situ' or local to the installation by virtue of ready removal (25kW compressor input power and above only).
c) A crankshaft-driven oil pump used to force-feed lubricant to the main and big end bearings and the shaft seal (6kW compressor input power and above only). A filter and oil suction strainer shall be incorporated within the oil lubrication system.
d) An oil pressure relief valve or bleed device provided between the oil pump discharge and the crankcase (6kW compressor input power and above only).

Open and semi-hermetic compressors shall have:

a) Provision for draining oil from the suction manifold into the crankcase and for venting refrigerant gas (but not oil) in the opposite direction.
b) A crankcase heater arranged to operate while the compressor is at rest with protection provided to prevent starting before the oil has reached the minimum operating temperature.

All types of compressor, except where indicated below, shall have the following provided and connected:

a) Service stop valves on compressor suction and discharge connections.
b) Resiliently mounted oil-filled refrigerant pressure gauges of minimum 65mm diameter, fitted with means of isolation, on suction and discharge with pressure calibrated in bar and saturation temperature for the refrigerant used calibrated in °C (6kW compressor input power and above only. Capped valved pressure tappings shall be provided below 6kW compressor input power).
c) Oil pressure gauge of minimum 65mm diameter with means of isolation (compressors with oil pump only).
d) Crankcase oil level sight glass (6kW compressor input power and above only).
e) Low oil differential pressure safety cut out with hand reset (compressors with oil pump in excess of 100kPa differential pressure only).
f) Refrigerant suction gas strainer.
f) Internal pressure relief valve on compressors in excess of 35kW input power.
g) Vibration isolation incorporated in the refrigerant lines of compressors located on anti-vibration mountings or where refrigerant lines are likely to transmit vibration.

Compressors having a refrigeration capacity in excess of 35kW shall have capacity control by means of either cylinder unloading or speed change and shall be arranged so

that starting is in the unloaded condition.

Hot gas injection into the refrigerant inlet of the evaporator will be permitted for capacity control as follows:

a) On compressors below 35kW refrigeration capacity, or
b) For compressors above 35kW, equal to the capacity of the final step.

3.14.2 CENTRIFUGAL COMPRESSORS

The compressor shall have automatic capacity regulation, which will control at any point from 1090 to 100% of full duty without inducing a surge condition or vibration. The compressor shall not be enabled to start unless in the fully unloaded condition. Unless otherwise indicated within this Specification and/or the Equipment Schedules, the hot gas bypass or injection system of capacity control will not be accepted.

The lubrication system shall be arranged with an interlock to ensure adequate oil pressure at all bearings before the compressor starts and during the 'coast down' period including conditions due to power failure. A replaceable or clean-able filter shall be positioned in the oil delivery pipe. A hand reset pressure or flow switch shall stop the compressor on a lubrication system failure. Where an oil cooler is used, it shall be thermostatically controlled. The oil sump shall have a thermostatically controlled electric heater, which operates while the compressor is at rest.

Where a multi-stage compressor is considered, it shall be shown that the work done in each stage is balanced at part-load operation.

The following shall be provided and connected:

a) Refrigerant pressure gauges;
b) Oil pressure gauge;
c) Oil sump or reservoir level sight glass.
d) Pressure operated safety cut outs;
e) Low oil pressure cut out or flow switch, both with hand reset facilities incorporated.
f) High oil temperature cut out with hand reset.
g) High bearing temperature cut out with hand reset.
h) High motor temperature cut-out with hand reset.

3.14.3 SCREW COMPRESSORS

The compressor shall have automatic capacity control equipment, which will control at any point between 10% and 100% of full duty. The compressor shall not be enabled to start unless in the fully unloaded condition.

The lubrication system shall be arranged with an interlock or other means to ensure adequate oil pressure at all bearings before the compressor starts. A hand reset pressure or flow switch shall stop the compressor on a lubrication system failure. The pipeline from a positive displacement oil pump shall incorporate a pressure-regulating valve to relieve excess oil to the reservoir. A replaceable or cleanable filter shall be positioned in the oil delivery pipe. A thermostatically controlled oil cooling system shall be used to remove heat gained by the oil. The oil sump shall have a thermostatically controlled electric heater. Lubrication systems, which obtain their pressure from the high-pressure vapour side of the refrigerant system, shall be allowed at the discretion of the Engineer.

A device shall be fitted to prevent the pressure differential across the compressor causing backward rotation at a normal or emergency stop.

The following shall be provided and connected:

a) Service stop valves on compressor suction and discharge connections.
b) Refrigerant pressure gauges;
c) Oil pressure gauge;
d) Oil reservoir level sight glass;
e) Low oil pressure cut out or flow switch, both with hand reset facilities incorporated.
f) High oil temperature cut out with hand reset.
g) Refrigerant suction gas strainer.

Compressors using oil injection for rotor sealing shall incorporate arrangements to prevent excessive oil carry-over with refrigerant from the compressor and ensure adequate oil return to the compressor over the full operating range.

Compressor units shall be suitable for continuous and automatic operation and be free of vibration.

3.14.4 SCROLL COMPRESSORS

Scroll compressors shall be of heavy construction to eliminate resonance and vibration and produce low operating sound level.

Compressors shall be hermetic type having a welded shell. Motors shall be suction gas cooled with solid state safety protection devices.

Compressors shall incorporate a discharge temperature thermostat and a refrigerant anti-reversal flow component.

The lubricating system shall include a centrifugal oil pump, oil heater and sight-glass.

Axial and radial fit of compression chamber surfaces shall be achieved with tip seals and swing link connector of orbiting scroll to motor shaft

Each refrigerant circuit shall include a compressor discharge service valve, liquid line shut-off solenoid valve, filter-dryer and sight-glass.

The control panel shall include separate sections for motor starters and automatic controls. Compressor motor contactors overload relays and termination strips shall be contained in the starter section. System protection switches, compressor hours run, compressor starts limiter and ambient temperature shall be contained in the control section.

High and low pressure gauges shall be provided.

Independent refrigerant circuits shall be provided where indicated within this Specification and/or the Equipment Schedules.

3.14.5 WATER CHILLING EVAPORATORS (SHELL AND TUBE TYPE)

Unless otherwise indicated within this Specification and/or the Equipment Schedules, evaporators shall be of the shell and tube type, capable of being re-tubed 'in situ'. An evaporator that cannot be re-tubed 'in situ' shall be readily removable. The design-fouling factor on the waterside shall not be less than 0.00009 m^2K/W unless otherwise indicated within this Specification and/or the Equipment Schedules.

The shell and tube plates shall be of steel and the water boxes/end covers of cast iron or steel. The tubes shall be of copper, aluminium-brass, or cupro-nickel. The water-box end covers shall be removable. Tube supports shall be fitted and may be of polypropylene, or other suitable and approved material, and shall prevent tube vibration. Water connections shall be flanged to BS 4504 and BS EN 1092-2 or have grooved ends for mechanical joint as specified.

Waterside drain and air venting provisions shall be made.

Provision shall be made on flooded evaporators for returning oil to the compressor. The oil rectification system shall ensure that refrigerant in the liquid form is not returned to the compressor. Full-length liquid droplet carry-over eliminators shall be fitted.

Flooded evaporators shall be fitted with a refrigerant level controller.

The refrigerant passages in a direct expansion water chiller shall ensure that oil present is always carried through at the lowest stage of capacity reduction.

The refrigerant and water spaces shall be pressure tested at the manufacturer's works.

3.14.6 AIR COOLING EVAPORATORS (DX COOLERS)

Air coolers (evaporators) using the direct expansion of a primary refrigerant shall comply with:

a) Coolers shall be provided with inlet liquid distributors and return suction headers arranged to ensure even distribution of refrigerant to all circuits and to return oil to the compressor. The tubes shall be staggered in the direction of airflow. Liquid distributors return suction headers and return bends shall be located out of the air stream.
b) All circuits shall have an even number of tubes to ensure that liquid and suction connections are on the same side.
c) On satisfactory completion of all manufacturers' works tests, batteries shall be dehydrated, charged with a dry inert gas and sealed.

The design of the refrigerant passages shall ensure that oil present is always carried through at the lowest stage of capacity reduction.

3.14.7 AIR-COOLED CONDENSERS

Heat exchanger materials shall be selected to minimise electrolytic action, be suitable for the operating conditions and be constructed from refrigerant quality seamless copper tubes with either aluminium, vinyl coated aluminium, copper, or Electro-tinned copper fins, as indicated within this Specification and/or the Equipment

Schedules. Fins with minor damage shall be properly combed straight. Units with extensive damage to fins will not be accepted. Provision shall be made for the purging of non- condensable from the condenser.

Air-cooled condensers mounted outside buildings shall have weatherproof motors. The units shall discharge air vertically upwards unless they are protected by an integral wind deflector or purpose - made baffle. The frame supports and casing of units shall be constructed material, which is either corrosion resistant or made proof against corrosion after manufacture.

Condenser design shall ensure equal air distribution over the full coil surface(s).

Unless otherwise indicated within this Specification and/or the Equipment Schedules, automatic control of the condensing pressure shall be incorporated. Where modulation of the outlet dampers is used, each fan motor shall be selected for this application and arranged so that it is de-energised on complete closure of the dampers.

Fans shall comply with the relevant Clauses of this specifications and particular attention being given to the permitted noise levels specified within this Specification and/or the Equipment Schedules, and shall be weather-resistant. Fan outlets shall be suitably protected.

Mechanical and electrical safety provisions for fans shall be in accordance with BS 848: Part 5.

Fans shall be 'type' tested in accordance with BS 848: Part 1 and Part 2 and be selected to deliver the required air volume flow rate and meet the noise level specified for the refrigeration machine within this Specification and/or the Equipment Schedules. Fan curves shall be submitted to indicate performance under all likely operating conditions.

Fans shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty, during starting, during stopping and during speed and duty changes.

Fans shall be installed using bolts, nuts and washers with all nuts properly locked and secured. All 'as cast' bearing surfaces for bolt heads and washers shall be machine counter faced. Holding-down bolts for fans and motors shall be provided with means to prevent the bolts turning when the nuts are tightened.

The shaft and impeller assembly of all fans shall be statically and dynamically balanced to BS 6861: Part 1. Limits of vibration severity shall be in accordance with BS 7854: Part 1.

Fan bearings shall be of a type suitable for the size, speed, loads and discharge angle of the fan and shall be greased/oil ball and/or roller type, oil lubricated sleeve type or sealed type where approved. Bearing housings shall be precision aligned and arranged so that bearings may be replaced without the need for realignment. Bearing housings shall be protected against the ingress of dust. For grease lubricated systems, the bearings shall be provided with grease in the quantity and quality recommended by the bearing manufacturer. Oil lubricated systems shall have an adequate reservoir of oil. All bearing lubricators shall be located to facilitate maintenance.

Gases handled by the fan or the local environment shall not affect finishes and materials of construction.

Fan casings shall be rigidly constructed of mild steel protected against corrosion or aluminium alloy and shall be stiffened and braced where necessary to minimize drumming and vibration. Mounting feet shall be provided where necessary for bolting to a base or supports. Electrical connections to the motors shall be through flexible conduit to external galvanised mild steel or plastics terminal box secured to the casing.

Provision shall be made for inspection of the fan impeller and motor. A removable inspection panel incorporating an air seal shall be fitted to casings 450mm diameter and above.

Impellers shall be of mild steel protected against corrosion, aluminium or moulded reinforced plastics. The blades shall be securely fixed to the hub. Alternatively, the blades and the hub shall be formed in one piece. The hub shall be securely fixed to the shaft.

Metal parts of condensers shall be bonded to earth. Lightning protection shall be provided where indicated within this Specification and/or the Equipment Schedules and/or drawings.

Air-cooled condensers assemblies shall be fully accessible for thorough cleaning. The manufacturer shall provide means and recommend frequency.

3.14.8 CONDENSERS (SHELL AND TUBE TYPE)

Shell and tube condensers shall have carbon steel welded shells. Manually cleanable copper, aluminium-brass, or cupro-nickel tubes shall be expanded into mild steel tube plates welded to the shell. All tubes shall be adequately supported and spaced, and shall be replaceable 'in situ'. Precautions shall be taken to prevent tube vibration. The design-fouling factor on the waterside shall not be less than 0.00018 m9K/W unless otherwise indicated within this Specification and/or the Equipment Schedules.

Water boxes/end covers shall be cast iron or steel protected against corrosion. End covers shall be removable to permit tube inspection, easy cleaning and replacement. Water connections shall be flanged to BS 4504 and BS EN 1092-2 or have grooved ends for mechanical joint as specified. Condenser position shall be so arranged to ensure tube removal or maintenance is unobstructed by pipe work, valves etc.

Waterside drain and air venting provisions shall be made.

Unless otherwise indicated within this Specification and/or the Equipment Schedules, automatic control of the condensing pressure shall be incorporated.

Means shall be provided for a balanced connection to the liquid receiver and for the controlled removal of non-condensables from the refrigerant side of the condenser. Automatic purge equipment shall have a visual signal fitted to indicate excessive purge cycles.

3.14.9 PRESSURE TESTING

Refrigeration equipment shall have a strength pressure test and a leakage pressure test after manufacture. Tests on the refrigerant side shall be made in accordance with BS 4434.

A strength pressure test shall be applied to the refrigerant system. The required test pressure shall be as shown in BS 4434. Waterside pressure tests shall be 1.5 times the working pressure.

A leakage pressure test shall be applied to the refrigerant system after all piping has been fitted. This test shall be in addition to the strength pressure test on each unit at completion of manufacture. The required test pressure shall be as shown in BS 4434.

3.14.10 REFRIGERATION PLANT ACCESSORIES AND CONTROLS

Every refrigeration system shall be protected by:

a) A pressure relief device unless it is so constructed that pressure due to fire conditions would be safely relieved. The means of discharge and equipment provided shall comply with BS 4434 and the outlet shall be piped to discharge outside the building in a safe location.
b) High and low refrigeration pressure safety cut outs with adjustable differential and set point. Hand reset to high pressure, hermetic units of less than 7.5kW input power may be fitted with factory-set high and low pressure safety devices at the discretion of the PM.

Where applicable, installations shall comply with the requirements of the Pressure Systems and Transportable Gas Containers Regulations. A written scheme for inspection shall be prepared a Competent Person.

Each refrigeration system with a refrigerant content greater than 10 kg shall be complete with suitable connections for the safe removal of the complete refrigerant charge.

A liquid receiver shall be fitted to systems using an evaporative condenser or an air-cooled condenser, unless the system is critically charged and utilizes capillary tube flow control. The entire charge shall be stored in 80% of the receiver volume. For systems having a water-cooled condenser with insufficient capacity to take the complete refrigerant charge, a liquid receiver shall be provided to make up the deficiency. Liquid receivers shall have means of venting, and means of determining liquid refrigerant level.

Where systems use a thermostatic expansion valve, the following components shall be provided upstream in the refrigerant liquid line:

a) A hand shut-off valve;
b) A capped refrigerant charging valve;
c) A refrigerant drier (replaceable element type);
d) A refrigerant strainer;
e) A combination liquid sight glass and moisture indicator;
f) A solenoid valve.

Where an evaporator pressure regulating valve i8 fitted, a strainer and an evaporator pressure gauge provided with means of isolation, shall be installed upstream of the

regulating valve.

Compressors, which may be required to start with exceptionally high evaporating temperatures, shall either have sufficient motor power available to meet this condition or be fitted with a device or system to limit the maximum suction pressure.

Where the compressor is expected to star' cold ambient conditions and the setting of the low pressure cut-out is such that it may operate during the start sequence, a device or system shall be incorporated to override this cut-out until suitable operating pressures have been established.

Units having a direct-expansion evaporator at a higher level than the compressor shall operate on a pump-down cycle. On water chilling installations, the chilled water pump shall continue running during pump down.

The flow of refrigerant to a multiple circuit direct-expansion evaporator shall be controlled by an externally equalised thermostatic expansion valve which shall not 'hunt' at any step of compressor unloading.

In a system where oil circulation or rectification is difficult, an oil separator shall be included.

Refrigerant service valves shall be of the capped type and incorporate a spindle gland of the back- seating type in which the gland is serviceable with the valve 'in situ'.

Flow sensing arrangements shall be provided in the chilled water pipeline to each shell and tube evaporator to prevent the compressor(s) starting or continuing to run if the water flow is below the minimum stipulated by the evaporator manufacturer. Flow switches shall incorporate a damping device.

A low temperature thermostat with hand reset shall be provided for each shell and tube evaporator to stop the compressor(s) if the chilled water flow temperature falls below 3°C.

Vibration isolation shall be provided to water chilling equipment in accordance with the Vibration Isolation and Noise Insulation Section of this Specification.

Starter and control panels shall be provided in accordance with the Starter and Control Panels Section of this Specification.

3.14.11 REFRIGERANT PIPING

Design, materials and installation of refrigerant piping systems shall be in accordance with Section 4, Part 1, of the 'Safety Code for Refrigerating Systems Utilising Chlorofluoro-carbons' published by the Institute of Refrigeration. Piping shall be of copper or steel.

To minimise the possibility of refrigerant losses to atmosphere, pipe work joints shall be kept to a minimum. Wherever possible, brazing or welding is preferable to flared, screwed or flanged connections.

All refrigerant pipe work shall be designed for the minimum pressure drop which ensures that oil in the refrigerant leaving the compressor is carried through the system and back to the compressor at the lowest stage of capacity unloading.

Design shall ensure correct refrigerant distribution to evaporator(s) with no liquid refrigerant drainage into compressor(s) during neither shutdown nor liquid entry during operation, and avoidance of lubricant accumulation and slugging in the suction line.

Copper suction, discharge and liquid lines up to 4 in (105mm) outside diameter (O/D) shall be fabricated from refrigerant quality tube to BS 2871: Part 2, Table 2- material designation C106. Tube shall be fully annealed up to Ys in (22mm) outside diameter (O/D) only. Tube shall be delivered to site internally degreased and shall be stored in clean and dry conditions with ends sealed until required for installation. Tube minimum dimensions shall be in accordance with Table 2A of this Specification.

Suction, discharge and liquid lines in steel shall be fabricated from seamless pipe complying with BS 3602: Part 1- material grade 360 minimum or higher qualities.

Plastic pipe, with compression fittings to BS 864: Part 3 may be used for feed piping to pressure gauges and similar fittings only where these are mounted on instrument or control panels. The grades of pipe used shall withstand the test pressure applied and the effects of refrigerant and oil. Plastic pipe will not be accepted for any other refrigerant piping.

Flared joints in copper piping systems will be accepted only on equipment accessories. Compression fittings shall not be used except where expressly called for in these specifications. Brazing shall be carried out in accordance with HVCA / JIB recommended practice and tests for competency 1990 (formerly HVCA Code of Practice TR/3) and BS 1723. Brazing rods shall be cadmium-free and conform to BS 1845.

Joints in steel pipe work shall be welded or flanged. Fabricated mitred or segmental bends, unless forming an integral part of equipment design, will not be permitted. Screwed joints will be accepted only on equipment accessories with either taper form of threads using an approved sealing compound, or parallel threads associated with machined joint faces and a suitable joint. Welding shall be carried out in accordance with HVCA/JIB Recommended practice and tests for competency 1990 (formerly HVCA Code of Practice TR/5), BS 2971 and BS 2640.

Brazers and welders shall be approved in accordance with a) to c) directly below, or shall complete the standard test procedure and gain a certificate of competency in accordance with the two relevant HVCA/JIB documents

a) Brazers and welders shall hold a valid certificate of competency issued by the appointed 'Inspection Body' or similar approved body. Unless otherwise indicated within this Specification, the Code of Practice (formerly TR/3) standard test piece will be the accepted test of competency. Brazers and welders without valid certificates and those without relevant brazing work experience within the preceding 3 months shall undertake the (formerly TR/3) test, witnessed and certified by the appointed 'Inspection Body', before commencing work.
b) Each brazer shall permanently identify each of their joints with their own marker, which will withstand site conditions without damaging system or component performance. Methods of marking shall be approved.
c) The appointed 'Inspection Body' during the system pressure tests will carry out visual examination and non-destructive testing of joints. The test criteria shall be those stated in HVCA/JIB Recommended Practice (formerly HVCA TR/3).

Steel pipe shall be clean and free from all forms of debris including rust, mill scale, flux and welding scale. Pipe shall be stored in clean dry conditions until required for installation. Ingress of dirt and moisture shall be prevented at all times, including during fixing operations, by sealing or use of end caps.

Piping shall be firmly supported in accordance with the Pipe work Section of this Specification and secured to minimise vibration. Centre spacing for refrigerant pipe work shall not exceed those given in Table 2B of this Specification Provision shall be made to accommodate thermal expansion and contraction. 'Cold bridging shall be prevented. Vibration eliminators shall be fitted to the compressor suction and discharge pipes to minimize transmission of vibration or noise. Where indicated within this Specification and/or the Equipment Schedules, a gas pulsation damper shall be fitted in the refrigerant discharge pipe, in the plant room, as close as possible to the refrigeration compressor.

After completion, the refrigerant pipe work shall be subjected to pressure and leakage tests. The use of a number of compressors each having an independent refrigerant circuit in a common evaporator will be permitted provided that an independent pressure test and an independent leakage test is carried out on each refrigerant circuit.

Two compressors may be connected in parallel if arrangements are incorporated to:

a) Ensure adequate oil rectification and oil balancing within compressors, and
b) Eliminate accumulation of liquid refrigerant within delivery side fittings during any compressor-off cycle.

3.14.12 THERMAL INSULATION

Materials shall be in accordance with the Thermal Insulation Section of this Specification. The insulation shall be protected by a vapour barrier, which shall not be broken down between joints of sectional material, nor at discontinuities at valves, fittings or supports. The application method shall prevent the ingress of moisture through the insulation to the cold surface. The permeance of the vapour barrier shall not exceed 0.01 g/s (MN). The thickness of insulation shall be to BS 5422. Where the indicated thickness in BS 5422 tables is not a commercial size, the nearest larger commercially available thickness shall be provided.

Shell and tube evaporators shall be insulated with a minimum thickness of insulation suitable for the application. This shall be 19 mm insulation unless otherwise indicated within this Specification and/or the Equipment Schedules and/or drawings. Where the insulation does not possess a smooth surface suitable for painting, a sheet metal casing shall be fitted. The insulation, (and casing where fitted), shall be arranged so that minimal damage is caused during removal of the evaporator end covers.

Liquid refrigerant pipes external to buildings and subject to solar radiation shall either be shielded or have 12mm thickness (minimum) of weatherproofed closed-cell insulation applied, with a reflective or light coloured finish.

Discharge pipes likely to cause burns to personnel shall be shielded.

3.14.13 DRY COOLERS (AIR-COOLED FLUID COOLERS)

The location of dry cooler(s), relative to the building, shall not impede airflow through the unit. Where possible unit coils shall be protected from direct sunlight. Airflow through the unit shall not be restricted by associated water distribution pipe work.

Heat exchanger materials shall be selected to minimise electrolytic action, suitable for the operating conditions and constructed from seamless copper tubes with either aluminium, vinyl coated aluminium, copper or Electro-tinned copper fins, as specified within this Specification and/or the Equipment Schedules. Fins with minor damage shall be properly combed straight. Units with extensive damage to fins will not be accepted.

Coolers mounted outside buildings shall have weatherproof motors. The units shall discharge air vertically upwards unless protected by integral wind deflectors or purpose made cases. The frame supports and casing of units shall be constructed of material, which is either corrosion resistant or made proof against corrosion after manufacture.

Unit design shall ensure equal air distribution over the full coil surface(s). For multi-fan arrangement, each fan shall be complete with baffles or separate chambers to eliminate short-circuiting and spinning of de-energised fans.

Water connections shall be male BSP or flanged to BS 4504 and BS EN 1092-2 as indicated within this Specification and/or the Equipment Schedules and/or drawings.

Fans shall comply with fans section of these specifications. Particular attention shall be given to the permitted noise levels indicated within this Specification and/or the Equipment Schedules. Fans shall be weather-resistant and fan outlets shall be suitably protected. Fan motors shall be single or multi-speed type as indicated within this Specification and/or the Equipment Schedules and/or drawings.

Mechanical and electrical safety provisions for fans shall be in accordance with BS 848: Part 5.

Fans shall be 'type' tested in accordance with BS 848: Part 1 and Part 2 and be elected to deliver the required air volume flow rate and meet the noise level specified for the refrigeration machine within this Specification and/or the Equipment Schedules. Fan curves shall be submitted to indicate performance under all likely operating conditions.

Fans shall be constructed to proven design standards and shall be capable of withstanding the pressures and stresses developed during continuous operation at the selected duty, during starting, during stopping and during speed and duty changes.

Fans shall be installed using bolts, nuts and washers with all nuts properly locked and secured. All 'as cast' bearing surfaces for bolt heads and washers shall be machine counter faced. Holding-down bolts for fans and motors shall be provided with means to prevent the bolts turning when the nuts are tightened.

The shaft and impeller assembly of all fans shall be statically and dynamically balanced to BS 6861: Part 1. Limits of vibration severity shall be in accordance with BS 7854: Part 1.

Fan bearings shall be of a type suitable for the size, speed, loads and discharge angle of the fan and shall be greased/oil ball and/or roller type, oil lubricated sleeve type or sealed type where approved. Bearing housings shall be precision aligned and arranged so that bearings may be replaced without the need for realignment. Bearing housings shall be protected against the ingress of dust. For grease lubricated systems, the bearings shall be provided with grease in the quantity and quality recommended by the bearing manufacturer. Oil lubricated systems shall have an adequate reservoir of oil. All bearing lubricators shall be located to facilitate maintenance.

Gases handled by the fan or the local environment shall not affect finishes and materials of construction.

Fan casings shall be rigidly constructed of mild steel protected against corrosion or aluminium alloy and shall be stiffened and braced where necessary to minimize drumming and vibration. Mounting feet shall be provided where necessary for bolting to a base or supports. Electrical connections to the motors shall be through flexible conduit to external galvanised mild steel or plastics terminal box secured to the casing.

Provision shall be made for inspection of the fan impeller and motor. A removable inspection panel incorporating an air seal shall be fitted to casings 450mm diameter and above.

Impellers shall be of mild steel protected against corrosion, aluminium or moulded reinforced plastics. The blades shall be securely fixed to the hub. Alternatively, the blades and the hub shall be formed in one piece. The hub shall be securely fixed to the shaft.

Unless otherwise indicated within this Specification and/or the Equipment Schedules, fans shall be controlled individually or in pairs in conjunction with a step controller and fluid temperature sensor.

Cooler coils shall be tested before leaving the manufacturer's works. A test certificate shall be issued for each coil or each coil shall be indelibly marked with details of the test.

Each cooler coil shall be leakage tested by using air under water to 1.5 times the working pressure or 8 bar gauge pressure, whichever is the greater, for 30 minutes.

Self-sealing test points suitable for temperature and/or pressure testing shall be provided on the inlet and outlet connections to each cooler. One thermometer and one pressure gauge for each range of temperatures and pressures, suitable for use with the test points, shall be packed in a protective casing and handed to the Engineer together with an adequate supply of any necessary insertion lubricant. Test points shall be fitted with captive caps and have internal self-sealing devices. The test points and probes shall be of materials suitable for the application.

Metal parts of coolers shall be bonded to earth. Lightning protection shall be provided where indicated within this Specification and/or the Equipment Schedules and/or drawings.

Dry coolers assemblies shall be fully accessible for thorough cleaning. The manufacturer shall provide means and recommend frequency.

3.14.14 EVAPORATOR BLOWER COIL UNIT

Fan powered evaporator blower coil units of the number and capacity specified in the Particular Specification shall be provided in the rooms and positions and cabinets, where applicable indicated on the drawings.

The units shall be suitable for the room temperature specified and shall be complete with fan/s, cooling coil, drip tray, thermostatic expansion valve, heat exchangers, etc. as a matched unit with the condensing unit.

Cooling coils shall be suitable for direct expansion air to refrigerant heat transfer at the specified temperature and temperature difference. Coils shall be of extended surface type constructed of seamless copper tube with mechanically bonded aluminium or copper fins.

For low temperature applications (freezer room and freezer cabinet) fin spacing shall be adjusted to suit.

Thermostatic expansion valves shall be fitted with external equalisers where required.

Coil construction and design shall ensure complete coil drainage from coil.

Fan motors shall be fitted with overload protection. Motor and impeller protection screens shall be fitted as applicable.

Drain pans shall be fitted to all blower coil units to collect water condensing on the coil and defrost water. The pan shall be constructed from galvanised steel sheet or stainless steel, at least 1,6mm thick. The pan bottom shall slope from all sides towards the drain point. The drain point shall be fitted with a screwed, 20mm diameter or larger outlet, depending on coil size and application.

The drain from the drip-pan shall be piped to the nearest building or plant-room drain with 22mm or larger copper tubing.

Automatic defrost control shall be fitted to all freezer rooms and freezer cabinets. Unless otherwise specified in the Particular Specification defrost shall be by means of hot gas by-pass control or electric heater elements. Where electric heater elements are to be used, these shall be three-phase type balanced across the phases. Drain pans shall be fitted with electric heater elements for defrosting and drain piping shall be fitted with heater tape to prevent freezing up.

Unless otherwise specified in the Particular Specification all cold and freezer rooms and freezer cabinets shall be fitted with thermostatic control.

Blower coil casings shall be all aluminium construction, preferably embossed.

3.14.15 DRAIN PIPING

Cold rooms, body cabinets and body freezer cabinet blower coil drain pans shall be fitted with copper drain piping at least 22mm in diameter.

Freezer room blower coil drain pans shall be fitted with copper drain piping at least 35mm in diameter. Drain piping shall be taken to the nearest drain point.

Drain pipes from drain pans for freezer rooms and body freezer cabinets shall be wrapped with heater tape over its entire length inside the room or cabinet to prevent freezing up. "Non-drip" tape or equal insulation shall be provided over the heater tape and piping. Heater tape shall remain switched on while cooling is in use.

3.15 PREFABRICATED COLD/FREEZER ROOMS

3.15.1 General

Prefabricated cold/freezer rooms shall be installed in the positions indicated on the main drawings.

Unless otherwise specified in the Particular Specification wall insulation thickness shall not be less than specified herein.

Minimum internal dimensions of room sizes required are indicated in the Particular Specification or on the main drawings. Actual dimensions must be determined on site before manufacture of panels.

External dimensions of rooms shall be planned to utilise available space to the maximum.

Pressure/vacuum relief valves shall be installed in all freezer rooms.

Each cold/freezer room shall be fitted with a 100mm diameter dial type thermometer above the door. The capillary tube for the thermometer shall be taken through the wall in a 20mm diameter sleeve pipe sealed with silicone sealant on both sides.

The bulb shall be installed 25mm off the wall in a top corner of the room as high as possible but not directly in the air stream of the blower coil unit.

Thermometer range shall match the application.

3.15.2 Walls and Roofs

Factory fabricated modular panels securely fastened together shall be used in the construction of free standing cold and freezer rooms and where required for internal lining of rooms of conventional construction.

Panels shall form a continuous vapour barrier on both the inner and outer skins of the total cold/freezer room envelope, including floor insulation where specified.

Panels for walls and ceilings shall be composite panels composed of insulation material clad on two sides with sheet metal to form a stressed metal skin securely bonded to the insulation.

Insulation material shall be fire retardant with minimum thickness and density as set out hereunder; (unless otherwise specified in the Particular Specification)

a) Cold rooms (0ºC and higher)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	100	24
Polyurethane	70	40

b) Freezer rooms (below 0ºC)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	150	24
Polyurethane	100	40

Panel skins shall be of galvanised steel sheet at least 0,6mm thick, surfaces prepared to match the finishing materials to be applied.

The skin side to be bonded to the insulation shall be prepared and coated with epoxy or vinyl primer compatible with the adhesive and insulation to be used.

The visible side of the metal skin shall be coated with baked silicone polyester or vinyl in an off- white colour.

Panels shall be protected with removable protective plastic coating during transport and erection and to be stripped at the appropriate time.

Damaged panels shall be rejected.

No horizontal joints will be accepted in wall panels and no timber may be used in the construction of any of the panels.

Paneling and framework around the door opening shall be reinforced to ensure that no warping of walls or cladding occurs.

All wall to wall, wall to floor, roof to roof and roof to wall joints shall be extruded aluminium or PVC sections designed and shaped for the application.

The extrusions shall be sealed and riveted to the panels at intervals not exceeding 500mm.

All panels shall be fully factory pre-finished complete with necessary joint and spline grooves, mitred corners and step edges ready for erection on site with the jointing system.

All joints external to the room shall be sealed with a non-hardening butyl rubber or silicone mastic sealant applied through the cartridge method.

All joints internal to the room shall similarly be sealed with silicone sealant.

Vertical joints in wall panels and horizontal joints in ceiling panels shall be covered with 38mm wide extruded aluminium "Tee" sections riveted to the panels at intervals not exceeding 500mm and sealed with silicone sealant.

Corner joints internal and external to the room shall be covered by 38mm x 38mm x 4mm thick extruded aluminium angle riveted to the panels at intervals not exceeding 500mm. Silicone sealant shall be applied to prevent the ingress of moisture between the angles and panels and floors.

Alternative jointing methods shall be approved by the Engineer prior to manufacture.

3.15.3 Doors

Doors shall be of sliding or hinged type as specified in the Particular Specification and/or main drawings.

Unless otherwise specified doors shall provide a clear opening of at least 815mm with the door opening reinforced and finished in PVC or aluminium sections.

Door insulation, finishes and cladding shall be as specified for the wall panels. Door corners shall be neatly reinforced.

Provision shall be made for an external padlock. The locking mechanism shall be such

that it shall be possible to open the door from inside the room under all circumstances, including when locked.

Swing type hinged doors for freezer rooms shall not be fitted flush with the wall panels but shall fit "slam-on".

Doors fitted to rooms with room floor on the same level as the exterior floor shall be provided with cam type (hinged) and drop in, drop down (sliding) hinges to seal properly on the floor.

Drag type seals or gaskets will be rejected.

Rubber back stops shall be fitted to all doors to prevent damage to doors and walls on opening.

Sliding door tracks shall be manufactured from heavy duty extruded aluminium sections at least 75mm x 80mm x 4mm thick.

The rails shall be fixed solidly and firmly to the wall panels by means of heavy aluminium or galvanised steel sections.

Each door shall be provided with at least two sets of rollers, bolted to galvanised steel brackets at each end of the door.

Rollers shall be fitted with sealed and lubricated ball bearings, each roller set individually adjustable to ensure proper alignment of the door.

All doors shall be fitted with chromium plated pull handles.

Hinged doors shall be fitted with robust heavy duty hinges capable of handling the door weight and frequent use.

Wall panels shall be suitably reinforced internally to ensure solid and robust fixing of door fixtures.

Doors shall be fitted with rubber or neoprene balloon type gaskets sealing properly and tightly with the door in the closed position.

Gaskets shall be removable to enable replacement. Gasket systems fitted to the door

shall be rejected.

Doors and/or frames for freezer rooms and freezer cabinets shall be fitted with double trace wire heater elements at least 22 W/m around the full opening, ensuring that gaskets do not freeze to wall elements.

Heater elements shall remain switched on while cooling is in use.

3.15.4 Floor Finishes

Where specified in the Particular Specification floor finishes forming part of the cold room installation shall be as set out hereunder.

Granolithic finish to floors, thresholds and similar horizontal surfaces shall not be less than 25mm thick, composed of 2 parts granite, or other approved hard stone chipping, or approved hard coarse sharp washed granitic or quartzitic sand, graded up to a maximum size of 5mm, half part clean pit sand screened through a 2,4mm mesh sieve and 1 part of cement, and hand or mechanically steel trowelled to a true and smooth surface.

No dry cement powder or grout shall be applied to the surface.

The granolithic shall be laid before the concrete sub-floor has matured otherwise the exposed surface of concrete shall be thoroughly cleaned with a wire brush, and a coat of neat cement grout applied immediately before the granolithic is laid.

Where granolithic is to be tinted it shall be laid in two thicknesses in one operation, the lower thickness brought up to within 6mm of the finished level, and the upper thickness then laid into which the requisite quantity of approved colouring material shall have been mixed. NO DUSTING OF COLOURING MATERIAL WILL BE ALLOWED.

Exposed salient angles of granolithic shall be neatly rounded to approximately 20mm radius.

All granolithic work shall be done by experienced workmen, and shall be protected from injury caused by rain or other extreme weather for 24 hours after being laid, and against too rapid drying whilst hardening, by being covered with wet sacks, or other suitable material, and shall be protected from injury and discoloration during the progress of the remaining work.

Edges of granolithic floors butting against different floor finishings, and edges of margins, etc., shall be true and sharp, and shall be protected by fixing temporary wood strips, which shall remain in position until the commencement of the laying of the adjoining floor material.

3.15.5 Floor Insulation

Cold room floors shall only be provided with insulation where specified in the Particular Specification. Insulation shall be as specified for freezer rooms.

All freezer room floors shall be fitted with insulation.

The concrete base (provided by the Builder, unless otherwise specified) shall be thoroughly cleaned and free of loose materials etc. Where necessary it shall be brought to a fair finish with a cement and sand plaster.

An underfloor vapour barrier of 0,25mm thick polyethylene membrane, forming a continuous envelope with the wall structure shall be provided on the prepared concrete base. The vapour barrier shall be totally pin hole free and shall have lapped joints at least 150mm wide, sealed with a minimum of two runs of non-hardening butyl rubber sealant.

Insulation shall be laid on the vapour barrier in a single layer with tightly butted joints.

Insulation material shall be fire retardant with minimum thickness and density as set out hereunder; (unless otherwise specified in the Particular Specification)

MATERIAL	MIN. THICKNESS (mm)	DENSITY (kg/m³)
Polystyrene	100	32
Polyurethane	100	40

Floor insulation shall be covered with reinforced concrete at least 75mm thick.

Floors shall be capable of withstanding distributed loads of not less than 10kPa and concentrated loads such as at rack feet of 10MPa.

Unless otherwise specified in the Particular Specification floors shall be finished with a 25mm thick granolithic screed floated to a smooth finish.

Where a tile finish is specified the concrete topping shall be finished with a wood float.

3.15.6 SHELVING

Shelving where specified in the Particular Specification or on the main drawings shall be constructed as set out hereunder, entirely from stainless steel grade 304.

Framework for shelves shall be constructed of rectangular stainless steel tubing not smaller than 25mm x 25mm, 2mm thick. Legs shall be fitted with load spreading stainless steel feet plates not less than 80mm diameter (or equivalent area if square) and 4mm thick.

Shelves shall be manufactured from 1,2mm thick stainless steel sheet with a 2B finish and fixed to the framework with cleats and brackets to form a robust freestanding unit.

No sharp edges or corners will be accepted.

The top surface of a shelve shall be smooth and flat to enable containers to be slid on and off.

Shelving shall be properly stiffened and braced and capable of supporting a mass of 150kg/m² on all shelves simultaneously.

Shelve units shall be at least 550mm deep and 1,8mm high with four shelves spaced at 450mm vertically.

Shelve lengths shall be provided to allow maximum storage space as indicated on the main drawings.

3.15.7 MEAT RAILS

Meat rails where specified in the Particular Specification or on the main drawings shall be constructed as set out hereunder.

Meat rails shall be floor standing and firmly bolted to the floor.

The stanchions shall be not less than 80mm diameter medium class piping with 300mm diameter x 12mm thick welded baseplates and four 12mm diameter holding down stainless steel bolts per baseplate.

The stanchions complete with baseplates shall be hot dip galvanised after manufacture.

The rail shall be manufactured from not less than 50mm x 12mm thick stainless steel flat bar.

The rails shall be suspended from a crossbeam not less than 150mm x 50mm x 6mm thick mild steel channel which in turn is bolted to and supported on the stanchions.

The crossbeam shall be hot dip galvanised after manufacture.

Suspension supports for the rail from the crossbeam shall be not less than 50mm x 12mm thick stainless steel flat bar.

The entire meat rail unit shall be bolted together with stainless steel bolts and nuts not less than 12mm diameter.

Top of meat rail height shall be not less than 2000mm above finished floor level.

Rails shall be designed to safely support up to 500kg/m length.

Rails shall be equipped with not less than four stainless steel hooks per metre rail length or as specified in the Particular Specification.

3.15.8 LIGHTS

Cold /freezer rooms shall be equipped with lights generally at not less than 1 light per 10m². No room shall however have less than two lights fitted.

Lights shall be wired from the refrigeration control panel with a separate circuit breaker.

A combined light with indicator pilot light for control of the lights shall be next to the door for each room.

The light switch shall be finished in neat baked enamel to blend in with the panel finish and shall be to the manufacturer's standard.

Lights must be symmetrically spaced with regards to the shelves and rails to ensure maximum light in passages and all parts of the rooms.

The lights and fittings complete with wiring must be entirely moisture proof and suitable for cold /freezer room applications.

PART 4:
PARTICULAR SPECIFICATIONS
KISII CANCER CENTRE - KISII COUNTY, KENYA

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4 PARTICULAR SPECIFICATION FOR AIR-CONDITIONING & MECHANICAL VENTILATION

4.1 General

This section specifies the particular requirements for air conditioning and mechanical ventilation plant, equipment and materials forming part of the sub-contract works and shall apply except where specifically stated elsewhere in the specification or on the contract drawings.

4.2 Scope of Works

The contract works consist of the supply, delivery, erection, testing, commissioning and setting to work of the air conditioning equipment and mechanical ventilation works detailed in the specification and accompanying contract drawings. The sub-contractor shall include for all appurtenances and appliances not particularly called for in this specification or shown on the contract drawings but which are necessary for the completion and satisfactory functioning of the sub-contract works

No claims for extra payments shall be accepted from the contractor due to his failure to adhere to the above requirements. It is deemed that if in the opinion of the tenderer at the time of tendering there exists a difference between the specification and the contract drawings, that the tenderer has clarified these with the project manager/engineer before tendering.

The works to be installed under this sub-contract shall comprise, but not restricted to the following:

1. Supply and installation of air conditioning equipment including refrigerant pipework and all the necessary controls;
2. Supply and installation of mechanical ventilation systems including the ductwork and controls;
3. Electrical works associated with the installation.

1.1 Air Conditioning

The equipment described here under covers the specific requirements of equipment to be used for these sub-contract works and shall be used in conjunction with the accompanying contract drawings.
It shall be deemed that the tenderer has based his tender on plant and equipment which is equal in performance to that stated within the specification.

1.1.1 Climatic Conditions

The following climatic conditions apply and all the materials and equipment used shall be suitable for these conditions:

CLIMATIC CONDITIONS	KISII TOWN
Maximum out door dry bulb Temperature, t_o	30˚C
Minimum Temperature	12˚C
Relative Humidity	41% - 97%
Altitude	1730 M ASL
Longitude	34˚ 47’ 01” E
Latitude	-0˚ 41’ 06” N
Max. solar radiation occurs during the month of February	

1.2 Air Handling Unit

1.2.1 General

The Air Handling Unit (AHU) shall be of double skin construction draw through type with 50mm thick panels comprising of the following:

1) Air intake panel comprising of intake louvers, opposed blade volume control dampers, bird and insect screen;
2) Course Dust Filter panel comprising of G3 class washable pre-filter capable of 80 - 90% average synthetic dust weight arrestance;
3) Fine Dust Filter class F7 or F8 as described;
4) Pressure differential gauges across every filter panel;
5) Centrifugal fan panel, comprising of Variable / Constant speed squirrel cage induction motors as described, V-belt driven centrifugal fan sized to match the flow rate and the pressure loss;
6) Direct expansion (DX) cooler /heater coil sized to achieve the rated cooling / heating load and fabricated out of copper tube & aluminium fins in robust construction and connected to a condensing unit utilizing environmental friendly refrigerant;
7) Condensate drip tray and drainage system;
8) Fresh and Return air mixing chamber;
9) Duct connections;
10) The unit shall have one spare compartment for future use;
11) Sound attenuator to reduce the fan noise reaching the nearest air supply point of the occupied space to 40 dBA shall be included as part of the AHU.

1.2.2 Type 1 AHU

The air handling unit (AHU) shall be a double skinned 100% fresh air unit complete with a 30 kw direct expansion (DX) cooler coil unit, utilising low ODP refrigerant (R404) and capable of delivering the conditioned air at 10^{o}C saturated. The fan shall be a variable sped fan, whose speed shall be pressure controlled with the pressure sensor placed in the header duct serving Type 3 AHUs.

The AHU shall have the following characteristics:

- On coil air conditions: 30^{o}C, 40% RH;
- Off coil air conditions: 10^{o}C, Saturated;
- Air pre - filters: G3;
- Air filter: F7 short bag filter;

- Air flow rate: 1.5 m^3/s @ 500 Pa;
- Cooling Only Coil: Capacity 30 Kw;
- Attenuators to limit noise outbreak to 40dBA.

1.2.3 Type 2 AHU

The air handling unit shall be a double skinned 100% fresh air unit complete with heat recovery wheel, direct expansion (DX) cooling / re-heat coil unit, utilising low ODP refrigerant (R134a or R410), two speed fan, F7 fine dust filter, HEPA filters and duct connections.

- On coil air conditions: Mixed external and Type 1 AHU air;
- Air pre - filters: G3;
- Air filter: F7 short bag filter;
- Air flow rate: Varies;
- Cooling / Heating Coil: as specified;
- Flow rate: as specified;
- Attenuators to limit noise outbreak to 40dBA.

The extract fan shall be provided with an isolation switch at a position to be determined on site inside the space.

The cooler /heater coils shall be connected to a heat pump VRF air conditioning system which shall be controlled by the room thermostat.

1.2.4 Type 3 AHU

The air handling unit (AHU) shall be a 100 % double skinned fresh air unit drawing at most 50% external air of its rated capacity and receiving the remainder at least 50% from the Type 1 AHU. The unit shall comprise of fresh air intake, course filter and fine filter panels, mixing chamber complete with the necessary volume control dampers, heat recovery wheel, direct expansion (DX) cooling / re-heat coil unit, utilising low ODP refrigerant (R134a or R410), two speed fan, fine dust filter, and duct connections.

The cooler /heater coils shall be connected to a heat pump VRF air conditioning system which shall be controlled by the room thermostat.

The AHU shall have the following characteristics:

- On coil air conditions: Mixed external and Type 1 AHU air;
- Air pre - filters: G3;
- Air filter: F8 short filter;
- HEPA filter:;
- Air flow rate: 1.5 m^3/s @ 900 Pa;
- Cooling / Heating Coil: as specified;
- Attenuators to limit noise outbreak to 40dBA.

1.3 VRF Air Conditioning Units

The variable refrigeration flow (VRF) air conditioning units shall comprise of step - less inverter speed controlled compressors. The compressors shall operate alternatingly such that the run time is evenly distributed among all the compressors.

Unless specified in the schedules, the unit shall be capable of simultaneous cooling and heating and the system shall incorporate a liquid /gas separator. In the heating mode, the system shall achieve a minimum Coefficient of Performance (COP) of 4.0 while in cooling mode, the minimum Energy Efficiency ratio (EER) shall be 7.0.

The unit shall utilize an environment friendly refrigerant eg R410A or R134a or approved equal.

The system shall include the necessary refrigeration pipework, Y joints, insulation etc. The maximum allowable pipework length shall be at least 90 m and the height difference between the lowest indoor and the outdoor unit shall be 30 m.

1.4 Split Air-conditioning System

The split air-conditioning system shall be designed to maintain room inside temperature of 22±1º C, the relative humidity shall not be controlled.

The air-conditioning system shall comprise of an indoor cooling unit and an outdoor condensing unit. The whole system shall be complete with the following:

- Evaporator unit;
- Direct expansion cooling coil with copper tubes and aluminium fins;
- Refrigeration pipe work with flared connections;
- Distributor with refrigeration system control;
- Environmental friendly refrigerant such as R134a, R410A or approved equal;
- Air-cooled condensing unit;
- Fixing brackets /wall mounting kit /ground mounting kit;
- Hard wired wall mounted room thermostat to control room temperature;
- High and low pressure units;
- Condensate discharge pipe work in Black PVC, 25mm diameter;
- Service access valves;
- Voltage Surge Protector.

The system shall be suitable for 240V, 1 – Phase, 50Hz power supply.

1.4.1 In-door Units.

The indoor units shall be complete with cooling coil, expansion valve, direct drive air circulation fan, thermostat for cooling control and condensate drain pump. It shall be provided with remote control unit.

The unit shall also have a filter unit of at least 65% efficiency, a decoration panel to fit between unit and the ceiling, an air suction grille and a hard wired remote controller.

The indoor unit shall be connected to power provided by others to the rooms. It shall also be connected to the condensate drainage pipework which shall discharge into the storm water drainage system, refrigerant piping and wiring for the control systems.

1.4.2 Out-door Units.

The outdoor units shall be installed and mounted on the wall / or at the roof using appropriate and approved mounting brackets /stand. They shall be complete with step - less inverter speed

controlled hermetically sealed compressors. Safety devices shall include overload /surge protection among others.

The unit shall be connected to power provided by others. It shall also be connected to refrigerant piping and control wiring. It shall have adequate charge of refrigerant and oil.

1.5 Smoke Exhaust Fans

Smoke exhaust fans shall be cabinet type centrifugal fan with external belt /or direct drive and motor. Fan and cabinet shall be suitable for smoke exhaust application & thermally rated for 300^{o}C for 2 hours as per [BS EN 12101-3:2002] Class-B. Motor and belt drive shall be mounted outside, so that it is not exposed to smoke stream. Fan blower shall be isolated from chassis with suitable isolators. Motors shall be suitable for 415 $\pm$10% volts, 50 cycles, 3 phase AC supply, energy efficient (IE2 as per BIS 12615:201) and static pressure shall be as indicated. Fans shall be activated from fire signal from fire alarm system or from DDC panel in case fans are also used for ventilation / free cooling. Flexible fire proof connection along with opposed blade volume control dampers at inlet and outlet shall be included.

1.6 Inline Fans

INLINE FANS Shall be cabinet extract fan, manufactured from galvanised steel sheet with double thickness side panels internally lined with 17 mm thick fireproof fiberglass acoustic insulation. The fan to incorporate a static and dynamically balanced backward or forward curved double inlet centrifugal impeller, rectangular /circular duct connection flanges and a remote terminal box.

Where axial fans are specified, they shall be suitable for installing in either vertical or horizontal position in line with the ducts. The fans shall be of double skinned casing, internally acoustically lined and constructed of galvanised steel.

The fans shall be DoL soft started with forward curve impeller fitted with maintenance free external rotor motor. The motor shall be suitable for three or single phase 50 Hz AC power supply. All units shall be complete with duct flexible connector and volume control damper at inlet and outlet.

The fan shall have low sound level exceeding not more than 40 DBA at three (3) metre distance. Necessary internal acoustic insulation to achieve this, if required, shall be included. Fans to be installed in the open shall have suitable for exposure to elements or equipped with canopy for rain water protection.

1.7 Axial Wall-Mounted Fans

Axial fans shall have impellers of Aerofoil section with variable pitch angle and manufactured from high quality die cast aluminum. Fan casing shall be L-type, hot dip galvanized steel plate.

Motors shall be of the totally enclosed type (IP55) with permanently lubricated bearings with speeds of not more than 1440 r.p.m. They shall be capable of operating in an air stream temperature of up to 500^{o}C. The fans shall be mounted on anti-vibration mountings and connected to ductwork by use of flexible connectors.

1.8 Roof-Mounted Extract Fans

Roof-mounted Centrifugal Fans shall have backward or forward curved wheel in galvanized steel sheet with the upper cover being of techno-polymer. The fans shall be of vertical discharge type with three or single phase motors.

1.9 Jet Fans

The jet fans shall be equipped with adjustable aluminium impellers and IEC standard motors, available for ambient temperatures for CO exhaust (between 40°C and 60°C) or for high temperature smoke exhaust rated at 300°C for 2 hours applications and certified in accordance with EN 12101-3. The fan shall be a two speed, high temperature fan that can also be used for normal CO extract ventilation and high temperature smoke extract fan. Three sizes and flow rates shall be as specified, with fully reversible blade settings and of either circular or octagonal low profile design.

Fan casings, outside sheet for fan housing and silencers shall be manufactured from pre-galvanized sheet. Fan module shall be sound insulated for low noise ratings. The outer fan casing shall allow easy access and the silencers shall have with integrated inlet cones and guide vanes to straighten the airflow. The sound attenuating material, shall be non-inflammable in accordance with DIN 4102, corresponding with EU guideline 97/69. Protection guards on inlet and outlet, shall be manufactured from powder coated steel. The fan shall include pre-assembled mounting brackets manufactured from galvanized steel, for safe and easy ceiling suspension. The fan module shall be easily removable for quick and easy maintenance. Outer jacket of fan module shall be provided with quick-lock for easy installation and removal. Deflector/guide vane on the outlet side.

Each fan shall be either individually or group controlled by a CO sensor and a control panel powered from a local isolator. The Sub-contractor shall provide the necessary power and control cabling from the local isolator to the control panel and to the fan and from the CO sensor to the control panel all fire rated.

1.10 Fan Controls

Fan control panels shall be fabricated from SWG 18 mild steel sheets powder coated after manufacture and shall have an integral lock. They shall also have an integral isolator which switches off power before the door opens. The panel shall be complete with:

- Contactors with current overload protection.
- Phase failure relay with over and under voltage protection.
- Programmable 24-hour timer switch
- M.C.Bs
- Selector switch for Auto or manual operation
- Indicator lights for fan ‘RUN’ and ‘TRIP’
- Switches /relays to switch off fans in the event of fire detection or the Automatic Fire Suppression system being operational.

All panels shall have **a name plate** to indicate what it serves or the zone being served. Panels shall be as manufactured by switch Gear controls or approved equivalent.

1.11 Silencers

Silencers shall be installed in the positions shown on the drawings. They shall be sized so as to allow the design air flow rate, pressure drop and velocity shall not exceed the manufactures recommended values or to cause noise generation within the silencer. The length shall be selected to allow adequate attenuation to reduce the fan noise reaching the nearest terminal unit to 40 dBA.

The silencers shall have aerodynamic splitters, sideliners, erosion protected infill, connection flanges and the casing construction to conform to DW 144 Class B duct work code. The infill shall have glass tissue facing and contained behind perforated metal sheeting to protect damage and erosion up to 30 m/s of the air way velocity.

1.12 Kitchen Extract Hood

The Extract Hood shall be of the size shown on the drawings and manufactured from grade 304 Stainless Steel Sheeting of 16 Standard Wire Gauge (SWG) and stiffened with steel tubes /bars as necessary. The hood shall be complete with the following:

1) A 75mm x 25mm high grease channel all around the bottom edge with 20mm diameter drainage holes all round. The holes shall have plastic plugs for drainage of grease.
2) Heat, water and moisture proof and easy to clean lighting.
3) Inbuilt fire suppression system with the extinguishing agent cylinders properly positioned near the hood and piped to strategically positioned nozzles in the hood complete with the control and actuation panel. The fire suppression system shall be as Piranha restaurant fire suppression system provided by Ansul or approved equal;
4) Hood supports made of suitable stainless steel chains /rods with enough strength to carry the weight of the hood suspended from the soffit as shown on the drawing and to Structural Engineers directions;
5) Grease eliminators made of a STAINLESS STEEL Vee bank unit for the main cooking area in the Halal Kitchen and single angle unit for the other kitchen hoods.

    i. The Kitchen Island cooking area hood shall incorporate at least 10 No filter panels capable of 14 m^3/h flow rate in a vee-bank unit with inlet on both sides and exiting at the top, complete with stainless steel grease drip tray at the bottom. The filters shall be as washable type from reputable manufacturer.;
    ii. The deep frying and grilling area hood shall incorporate at least 3 No filters capable of 6 m^3/h flow rate panels in a single angle unit with top exit, complete with stainless steel grease drip tray at the bottom. The filters shall be washable from reputable manufacturer.
    iii. The backing and steaming area extract hood shall incorporate at least 3 No filter capable of 6 m^3/h flow rate panels in a single angle unit with top exit, complete with stainless steel grease drip tray at the bottom. The filters shall be washable type from reputable manufacturer.

1.13 Wash Up Area Extract Hood

The Wash up area Extract Hood shall be of the size shown on the drawings and manufactured from grade 316 Stainless Steel Sheeting of 16 Standard Wire Gauge (SWG) and stiffened with steel tubes as necessary. The hood shall be complete with the following:

1) A 75mm x 25mm high condensate channel all around the bottom edge with 20mm diameter drainage holes all round. The holes shall have plastic plugs for drainage of condensate.
2) Hood supports made of suitable stainless steel chains /rods with enough strength to carry the weight of the hood suspended from the soffit as shown on the drawing and to Structural Engineers directions;

1.14 Extract Hoods Ductwork

All the duct work within the cooking area, bakery area and wash up area shall be constructed out of stainless steel sheeting in conformity with DW144. The duct work shall be as shown on the drawings, but spiral wound circular ducts would be preferred and shall be inclusive of all the necessary fittings such as fire and volume control dampers, transformation pieces, off sets, cleaning hatches, test holes, duct work hangers, flexible connectors etc all in conformity with DW 144.

1.15 Air Terminal Devices

1.15.1 General

This section specifies the requirements for the air terminal devices forming part of the mechanical ventilation and air conditioning systems.

Unless otherwise specified, the air terminal devices shall have the following characteristics:

1) The velocity across the air terminal devices shall not exceed 4 m/s;
2) The noise generation shall not exceed 35 dB(A);
3) The pressure loss shall not exceed 50 Pa.

1.15.2 Laminar Flow Diffusers

The laminar flow diffusers shall be suitable for use in hospital operating theatres. The laminar flow pattern shall be achieved by use of a primary baffle within the plenum chamber and a low free-area perforated discharge plate at the face of the diffuser. The diffusers shall either have flanged frame to suit the conventional exposed or concealed T ceilings or flangeless frame to suit modular panel construction.

The laminar flow diffusers shall be complete with a perimeter trim strip to suit the overall dimensions of the panel assembly, support brackets and mounting plates, volume control damper with a remote adjustment cable to be remotely operated using a screw driver in the theatre, HEPA filter capable of 99.99 % efficiency at 0.3µm. Filters shall be securely held in place by at least four mounting brackets allowing filter removal from the face of the diffuser without disturbing installed ductwork or the diffuser mounting surface. Filters shall incorporate a removable test port, to measure filter pressure drop, perform leakage (scan) tests and to adjust the balancing damper without removing the filter.

The face of the diffuser shall be out of adequately sized perforated anodized aluminum sheeting with at least 13% free area with 2.4mm dia. holes on 6mm staggered centers. The face shall be attached with 1/4 turn fasteners to allow for complete removal and access to the interior for cleaning. The diffusers shall include safety cables to prevent accidental dropping of the removable face.

The laminar flow diffuser shall be constructed out extruded aluminium frames and assembled using welding and soldering to form a robust construction. The perforated aluminium face plate shall be easy to remove for cleaning. The plenum chambers shall be manufactured from galvanised steel sheets with all the exposed edges and spot welds protected. The diffuser shall be factory insulated with a 25 mm thick polyurethane foam and finished off with aluminium cladding.

1.15.3 Door Transfer Grille

The door grilles shall be the NON-VISION type constructed from high quality extruded flanges and inverted “V” type horizontal blades with visible screw fixing. The blades shall be out of high quality extruded aluminium profiles and spaced at a distance of not less than 15 mm centers so as to allow a free area of 55% for air movement. The frame shall be on both sides of the and sized to suite.

Where door grilles are to be installed on a fire rated door, the grille shall have the same rating as the door as a minimum.

1.15.4 Diffusers

1.15.5 Disc Valves

The disc valves shall be used in the toilet air supply and extract systems. The disc valves shall be of circular construction and suitable for air supply and or extract. They shall comprise of valve ring with peripheral seal. The central disc shall have a lockable threaded spindle, locknut and installation sub-frame. The volume flow rate adjustment shall be by rotating the central disc and locking it in the desired position.

Face sections sheet steel with electrostatic powder coating (colour similar to RAL 9010, thickness 60 µm), galvanized steel threaded spindle and lock nut, installation sub-frame galvanised sheet steel.

1.15.6 Pressure control dampers

Pressure relief dampers shall be used to relief and maintain the space pressure difference with the surrounding spaces and thus protecting the internal spaces from differential pressures in excess of set maximum levels. When the set maximum differential pressure is exceeded, the blades automatically open to relieve the excess pressure.

The pressure relief dampers shall robust and of maintenance free construction, made out of galvanised sheet steel and where specified be suitable for duct connection. The pressure relief damper shall of comprise of the following:

- Rectangular casing: - material thickness 2 mm;
- Blades: - material thickness 3 mm;
- Flanges: - on both sides and suitable for duct connection, with or without flange holes;
- Adjustable retaining element: - to adapt to different pressures;
- Blades: - can be moved independent of or complementary to one another;
- Bearings: - Maintenance-free DU bearings with Teflon coating, bearing shafts made of stainless steel;
- Differential pressure: - Adjustable from 15 Pa to 50 Pa;
- Temperature range: - 0 to 80^{o}C;
- Seal: - Rubber air leak seals.

1.16 Filters

1.16.1 High Efficiency Particulate (HEPA) Filters

The HEPA Filters shall be designed and constructed to provide the highest level of filtration and suitable for use in hospital operating theatres and clean rooms. The HEPA Filters shall have an

efficiency of 99.99% on 0.3-micron size particles. The filters should be factory tested for efficiency and leaks and the compliance certificates issued.

The filter media shall be produced from sub-micron glass fibers formed into a water-resistant, high efficiency, high density wet-laid paper mat. The media shall be fire retardant to 400°C. The filters shall be provided with neoprene gaskets which shall be installed on the downstream side of the filter to prevent leakage between the filter and the frame upon installation in the filter housing. Precision-crafted corrugated aluminum separators shall maintain exact pleat spacing and ensure proper airflow throughout the filter's life cycle. The leading edge of each separator shall then be rolled over to create a separator that is strong to avoid damage to the air filter media. The frame shall be out of anodized aluminum for corrosion resistance.

1.16.2 Fine Filters

The short bag fine dust filters shall be classified as F7 shall have 80 - 90% of the average dust spot efficiency values and shall be the typical final filter to most of the spaces. The short bag filters shall measure 600x600x300 mm long and the air velocity across the filter shall be limited to 2.5 m/s with an overall air flow rate of 0.9 m^3/s with initial pressure drop of 80 Pa. The final pressure across the filter shall be limited to 250 Pa.

The bag fine dust filters classified as F8 having 90 - 95% of the average dust spot efficiency values and shall be the typical pre-filter to the HEPA filters. The bag filters shall measure 600x600x600 mm long and the air velocity across the filter shall be limited to 2.5 m/s with an overall air flow rate of 0.9 m^3/s with initial pressure drop of 80 Pa. The final pressure across the filter shall be limited to 250 Pa.

1.16.3 Grease Filters

The Filter bank unit shall have a bell mouth inlet with an insect screen and washable filters of 65% efficiency with an initial pressure drop of 45 Pa at the rated flow. The filters shall be as **Trox** or approved equivalent. There shall be differential pressure switches to enable dirty filter indication.

1.17 Duct Work in General

1.17.1 General

This section specifies the general requirements for mechanical ventilation and air conditioning plant, equipment and materials forming part of the sub-contract works and shall apply except where specifically stated elsewhere in the Specification or on the Contract Drawings.

1.17.2 Installation

Installation of all ductwork, plant and equipment shall be carried out under adequate supervision from skilled staff to the relevant codes and standards specified here-in.

The sub-contractor shall be responsible for ensuring that sufficient provision is made to prevent the transmission of vibration from equipment to the supporting structure. In case of fans, this shall be done by rot and vermin proof flexible connection and an anti-vibration mounting of an approved type.

The Sub-contractor shall ensure that all ducting systems are provided with sufficient access hatches complete with covers, for maintenance purposes.

Dampers and other user equipment shall be installed with adequate access for operation and maintenance. Where dampers and other operational equipment are unavoidably installed beyond normal reach and in such a position as to be difficult to reach from a short step ladder, extension spindles shall be provided.

The variety and type of supports for ducts, and fans shall be kept to a minimum and their design shall be such as to facilitate quick and secure fixing to both metal, concrete, brickwork and wood.

Where the design of the structure is in reinforced concrete, supports shall be secured to the structure by means of rod-heads, raw-bolts or other approved means. Where the sub-contractor proposes to secure his supports by other means than to the main structural concrete, he shall consult with the Architect/Engineer before proceeding.

1.17.3 Ductwork

The Sub-Contractor shall supply, deliver and erect all ductwork as shown on the Contract Drawings and Approved working Drawings. All ductwork shall be manufactured in accordance with the Chattered Institute of Building Services Engineers specifications (C.I.B.S.E) and or Heating and Ventilating Contractors Association (HVACA) Specification for sheet metal ductwork (DW/144), except where stated otherwise.

Unless otherwise specified, the ductwork shall be manufactured from galvanized mild steel sheet. All external ductwork shall be manufactured from black mild steel sheet and galvanized after manufacture. All seams shall be of lock-form type. All ductwork systems shall be complete with all necessary dampers, bends, tees, tapers, transformation and special pieces etc.

Where removal is required for access or maintenance, ducting shall be provided with steel angle flange joints suitably painted and protected.

All joints shall be fixed as to be suitable for the direction of air flow. All positions of plant and ductwork shall be checked on site before detailed manufacturing drawings are prepared and ductwork manufacture commenced. Transformation and taper pieces shall, where ever possible be constructed so that the included angle does not exceed 30^{o}.

All flanged joints shall be sealed by the use of suitable sealant compressed between the flanges, and where slip joints occur, these shall be sealed by ‘Prestik’ or other similar suitable jointing compound and adhesive tape 40mm. Exposed sheet metal edges shall be painted with galvatite before sealing.

Volume Control Dampers shall be of aerofoil section and manufactured from galvanized mild steel sheet and shall be installed in all the ductwork branches. Damper blades shall not exceed 150mm in width and the edges of the blades shall be sealed with a 3mm thick felt or rubber seal to minimize leakage. Operating quadrants shall be provided with locknuts and the quadrant shall be clearly marked with ‘open’ and ‘closed’ positions. **Multileaf** damper blades shall be operated by one arm through a linkage external to the duct and secured by a lock nut.

Access Doors; the Sub-contractor shall provide sufficient access doors and hand holes in the ductwork for the purpose of maintenance and inspection. Access doors shall be of the hinged type and door openings in the ductwork shall be adequately stiffened, and made airtight with purpose made rubber gaskets around the door perimeters.

All **support and brackets** shall be wire brushed and painted one coat of red oxide paint prior to and after erection. All nuts and bolts shall be spheradized. The fastening of electrical cables to ductwork will not be permitted.

All the duct work from the Air Handling Units shall be insulated and incorporate an external vapour seal. The ductwork shall be insulated from the support by a rot proof softwood, hardwood or other suitable closed cell insulation of not less than 25mm greater thickness than the insulation to be applied so that the vapour seal may be bonded to the face of the timber, all as detailed. Where ductwork passes through floors and walls, etc. galvanized sheet sleeves or builders work timber frame shall be provided. The space between the duct and the sleeve or frame shall be packed with mastic to prevent air movements or noise transmission from one space to another. Ducts must not come into direct contact with building fabric.

Hangers and brackets shall be manufactured from rolled mild steel angle or channel section and shall generally be of red drop rod hanger or cantilever type. The hangers shall be spaced to ensure adequate support and where practicable shall be fitted at each ductwork joint.

The Sub-Contractor shall supply and install, where called for, **louvers at inlets and outlets** with insect proof screens. The louvers shall be constructed throughout from extruded aluminum sections and shall have a lacquered or anodized finish to prevent corrosion. The louvers shall be weather-proof and have a free area of not less than 50%.

The sub-contractor shall ensure that wherever fans or similar equipment are connected to the ductwork system, the connections are made with a heavy duty rot and vermin proof of neoprene, or similar material, flexible connection to prevent transmission to the ductwork or building fabric. Flexible connections shall be secured by a pre-drilled mating flange, or when fixing to spigot, the spigot should be beaded and a jubilee clip or split flat iron ring should be used.

The Sub-contractor shall provide test holes in all branch ducts and in the main duct on the discharge of the fan. The holes shall be suitably spaced in accordance with B.S 848, shall be situated on a straight length of duct work and where possible, not less than 2 meters downstream of any bends or dampers. After the completion of testing the sub-contractor shall provide and fix proprietary metal or plastic plugs to all test holes. The use of drubber or cork bungs will not be permitted.

1.17.4 Fire Damper

The fire damper shall be installed in any duct that crosses a fire wall, slab or from one fire compartment to another. The fire damper shall be of single blade with flanges for mounting. The blade shall be held in position by a spring-loaded fusible link, set to release at a temperature of 85°C. The fire damper shall have a fire resistance of not less than three (3) hours. It shall have an access door for fusible link.

The damper shall have a switch operated by the blade, which shall switch off the fan when the blade shuts off airflow.

1.17.5 Insulation

All heated, cooled and re-circulated air duct work shall be insulated and cladded with 24SWG aluminium sheet. Insulation shall be of 25mm thick expanded polystyrene sheet, or spray applied polyurethane foam to a uniform thickness of 25mm, Polystyrene shall be fixed so that the edges butt closely without gap and the insulation shall overlap at corners by the thickness of the insulation. The sheet shall be fixed by means of a suitable adhesive and plastic impingement pines attached to the ductwork.

1.17.6 Ductwork in Plant Rooms

The insulation described above shall be finished by the application of a 15mm thick layer of hard setting plastic compound trowel led to a smooth finish. All corners shall be protected by setting in

a 1mm thick aluminum angle strip into the hard setting finish. Insulation shall be leveled to angle of 45 at all connecting flanges, access hatched and all other places where operation or maintenance is likely to cause the breaking of the insulation. The insulation shall then be given a vapour sealing by the application of two coats of anti-condensation paint. The insulation described above shall be finished by the application of two coats of bitmastic paint and cladded with 24 SWG aluminium sheet.

1.17.7 Finishing Paint

Upon completion of the installation and after all tests and system balancing has been carried out to the satisfaction of the Engineer, the plant, equipment supports, etc shall be examined and all priming coats damaged during erection made good. Any plant, equipment or duct work, etc. which is to be insulated, shall have had the priming paint protection made good before the application of the insulation. After the above procedures have been carried out to the satisfaction of the Engineer, the various surfaces shall be given the necessary preparation as recommended by the paint and insulation manufacturers and finish painted in colours to be agreed between the sub-contractor and the Engineer at a later date.

For the purpose of the specification, however, it shall be deemed that the sub-contractor's tender price shall be based on the identification and colour coding requirements for the various services.

1.17.8 Electrical Works

The electrical subcontractor shall be responsible for providing power to a local Isolator and connecting power to it. The ventilation subcontractor shall be responsible for the connections between the Isolator and the control panel. The panel shall be approximately three (3) meters from Isolator. The subcontractor shall be responsible for connections between the panel and the fan, fire damper and within the panel. Electrical works under this subcontractor shall include conduit works and a suitable weatherproof Isolator next to the fan.

1.17.9 Testing and commissioning

Site Tests
The Sub-contractor shall supply all instruments and equipment for the testing of associated equipment which may affect the performance of the plant installed under these sub-contract works.

Site Test -Fans
All fans shall be charged with a suitable lubricant and shall be tested upon completion of the ancillary system erection to ascertain that the performance of each fan complies with the requirements of the Specification.

Completion of Work – Balancing and Commissioning
Following the Site tests and prior to handover, mechanical ventilation systems shall be balanced by means of registers, dampers and other special controls installed, so as to give the required air flow rates and where applicable the desired temperatures, pressures and humidity conditions in all areas served by the said systems. Balancing shall be carried out as described in the **C.I.B.S.E Commissioning Codes**.

The complete systems shall be balanced and commissioned as a whole. Sectional balancing and commissioning on any one part of the systems where this excludes final complete systems balancing and commissioning shall not be accepted.

Tests volumes within ducts shall be within +_5% of the design volumes, and volumes at grilles and diffusers shall be within +_10% of the design volumes.

When the system has been balanced to the satisfaction of the Engineer it shall be run under complete automatic controls for 72 hours continuous operation to ascertain any faults in operation before acceptance and handover. Any faults discovered during this time shall be corrected and a further test or tests of 72 hours duration shall be carried out to ensure satisfactory operation, all at the expenses of the Sub-contractor.

1.18 COLDROOM

1.18.1 Scope of Work

The work described in this section comprises of supply, delivery, installation, testing and commissioning of cold and freezer room(s) equipment, door, wall, ceiling, floor insulation, and control panels with auxiliary equipment and wall finishes as specified in the material schedule. The room shall be constructed out of modular panels drawn and locked securely to the adjacent panels and foamed to form air and water tight joints.

1.18.2 Wall and Roof Insulated Panels

The cold room wall and roof shall be constructed from 1200mm wide by 100 mm thick standard insulated panels. The panels shall be manufactured from fire retarded closed cell rigid polyurethane foam injected using high pressure and securely bonded to galvanized steel facing on both sides to form a single panel. The foam insulation shall be free of HCFC with zero ozone depleting potential. The panels shall have an approximate thermal conductivity 0.023 W/M^{o}C at 10^{o}C and a density of approx. 40 - 44 Kg/m^3 for the walls and ceiling.

The panels shall be finished off in white food-safe corrosion resistant anti-static stay clean longer PVC laminated film on galvanized steel substrate to all wall surfaces and interior of ceiling. Exterior of floors and shall be finished in galvanized steel all painted to an agreed colour. The roof shall be installed with a slight fall to ensure that no water ponds in case of hosing.

1.18.3 Floor

The floors shall be constructed in situ and shall be insulated with polystyrene or approved equal and shall be applied in two layers each 50 mm thick for the cold rooms and 75 mm for the freezer room. The second layer shall be applied shall be applied staggered to break joints with the first layer laid give and good thermal barrier.

The insulation shall be applied over a 1000-gauge polythene vapour barrier. The insulation thermal conductivity shall be approximately 0.025 W/m ^{o}C and a density of approximately 40Kg/m^3. The floor shall then be finished off to the Architects requirements.

Care must be taken to avoid breaking the vapor seal when fixing the insulation. Two more coats of vapour seal shall then be applied after application of insulation

1.18.4 Insulated Door

The cold or freezer room doors shall be of size and thickness indicated in the schedules. The door shall be out of sandwiched HFC 40 kg/m3 polyurethane moulded foam with gauge 20 (0.9 mm) thick hot galvanised internal and external steel sheets completed with baked powder finish, of average thickness 70 µm. The door be rabbeted at the edges.

The doors shall be self-closing with three (3) lift-off spring stainless steel hinges. The frame shall be hot galvanised steel sheet with baked powder finish, thickness 2.0 mm. The door shall be surface mounted,

opening to the outside and may be of either left or right swing. The doors shall have an easy to replace double flexible magnetic seal to ensure an air tight seal.

The door shall be fitted with automatic plunger type switches for operating the fan motors and interior lights such that when it is open, the light shall go on and the fan shall stop, and when it is closed, the lights shall go off and the fan shall start.

The door shall be such that it can be padlocked from outside but with an inside release such that it can be opened from inside even when padlocked.

The door to be supplied with a door heater.

1.18.5 Evaporator

The evaporator shall consist of a cooling coil, air-circulating fan, fan guard, and defrost electric heater element(s) and a thermostatic expansion valve. The valve shall be pressure equalized and manually adjustable. A timer unit shall be mounted in the control panel to control both the de-frosting intervals and defrosting period – both of which shall be variable. The evaporators shall be of cooling load capacity as shown in the drawings and equipment schedule.

The evaporator shall be complete with a drip tray fitted with a drain pipe to the outside of the nearest drain point.

1.18.6 Condensing Unit

The condensing unit shall be of capacity to match with the evaporator-cooling load while using refrigerant R134a / R404A / R507A under the specified conditions. The unit shall be air-cooled semi hermetic with automatic capacity control for evaporator demand.

It shall be provided with suitable anti-vibration mountings and an initial oil change in the compressor. The unit shall be complete with compressor, electric motor, air-cooled condenser of non-ferrous construction, liquid receiver, all mounted on a common base. The unit shall be mounted on the outer stair case wall next to the Kitchen or as determined on site.

1.18.7 Refrigerant Pipework.

Pipework shall be approved refrigeration grade copper tubing and fitting and shall be properly fixed in conformity with the relevant British Standards. The suction line shall be insulated with at least 25mm thick of Armaflex or other approved material, which shall not have insulating properties inferior to those of cork. The positioning of condensing unit shall be agreed on site and the contractor shall make enough allowance for the refrigeration pipework and refrigerant charge.

1.18.8 Refrigerant Componets

The system shall be provided with the following components all from an approved manufacture:

- Filter drier;
- Sight glass with moisture indicator;
- Solenoid valve;
- HP/LP cut out switches;
- Suction & delivery gauges;
- Room thermostat;
- 100mm diameter surface mounted dial thermometer in degree Celsius.

1.18.9 Control Panel

The control panel shall be fabricated from mild steel sheet of minimum SWG18 with a hinged door and then powder coated after manufacture. It shall be provided with an integral lock. It shall be complete with;

1. Isolator fitted on the door;
2. Controlling thermostat with temp range from -30^{0}C to 30^{0}C;
3. 80mm dial thermometer with temp rang from -30^{0}C to 30^{0}C;
4. Contactors for defrosting coils;
5. Motor starters & current overload relays;
6. MCB's;
7. Phase failure relay with over and under voltage protection;
8. Timer switch for defrost control;
9. Push buttons for start and stop;
10. Audible and visual high temperature alarm with manual reset;

The panel shall also have green light running indicators, red "door open" light and equipment circuit trip lights.

1.18.10 Electrical Installation

The electrical sub-contractor shall be responsible for providing power to the control panel and for providing a local Isolator and connecting power to it. The cold room sub-contractor shall be responsible for the final connections to the above equipment, all control wiring and for all wiring within the control panel.

1.18.11 Meat Rails and Shelves

The sub-contractor shall supply and fix 75 mm class 'C' GMS tubing meat rails. All steel sections shall be hot dip galvanized.

1.18.12 Testing and Commissioning

Before insulation of the suction pipe the refrigeration system shall be tested for pressure and leaks using the combined pressure and leaks testing method. The refrigeration system shall be charged with R134a refrigerant and entire system raised to test pressure using nitrogen or other inert gas. The test pressure shall be twice the working pressure for the system.

Leaks shall be checked using soap bubble followed by using of electronic leak detector. After system is proved leak proof, it shall be maintained under test pressure for 24 hours. If at the end of this time the gauge pressure has fallen, the complete system shall be re-tested. After the successful completion of the test, the system shall be evacuated using vacuum for 24 hours. If there is loss of vacuum the system shall be dehydrated again and left under vacuum for a further 24 hrs until the system is effectively dehydrated.

After this the system shall be charged with the correct type and quantity of the refrigerant. The system shall then be set to work and adjusted to ensure that it operates correctly and design conditions are archived. It shall be left to operate for 72 Hrs and room temperatures recorded for this period using an automatic room temperature sensor/recorder.

The compressor shall be provided with identification plates stating the type of refrigerant used and the quantity required for the system.

PART 5:
BILLS OF QUANTITIES
KISII CANCER CENTRE – KISII COUNTY, KENYA

5 BILLS OF QUANTITIES

5.1 General Directions

(a) The Bills of Quantities are to be read in conjunction with the Conditions of Contract, the Specification, the Data Schedules and the Drawings for details of the description, quality, tests and strengths of materials to be used and the workmanship, conditions, obligations, liabilities and instructions generally which have to be complied with in carrying out this contract. The cost of complying with all Conditions of Contract, the Specification, the Data Schedules and the Bills of Quantities including all overhead charges and profit and carrying out of the Works shall be deemed to be spread over and included in the prices and sums in this Bill of Quantities.

(b) Each item which the Tenderer proposes to supply shall be priced by Tenderer with the exception of the item for which Provisional Sums have been allowed. The Tenderer shall insert in the appropriate column against each item allocated in United States Dollar (USD) as required by him and payments shall be made according to this allocation in the event of a contract.

If the Tenderer omits to price any item in the Bills of Quantities then the cost of such items will be held to be spread over and included in the prices given for other items of work.

(c) The Total of Tender shall be carried to the Form of Tender.

The Total of Tender shall include for the design, manufacture, inspection and testing, packing for shipment, insurance, customs dues, delivery to site, unloading, and all other charges, complete erection, testing, setting to work, finishing, painting, maintenance for a period of six calendar months and the instruction period all to the satisfaction of the Interior Designer and Engineer, of the items of Plant described or implied within the Specification and shown on the Drawings.

(d) Provisional Sums may be expended in part, in whole or totally deleted from the Contract. The tenderer shall take this into consideration when pricing the tender, as no claims for loss of profit, etc will be entertained.

(e) These Bills of Quantities have been measured from the Drawings listed, but do not purport to schedule the works in more detail or accuracy than is necessary to obtain a reasonable and comprehensive tender.

The contractor shall nevertheless be deemed to have included in his prices for all labour and all materials, accessories, components, quantities and commissioning to provide complete installation as described in Specification and shown on the Drawings as required by the true meaning and intent hereof. It shall be deemed that the contractor has included for all requirements contained within the Specification, Drawings, Data Schedules and Bills of Quantities.

(f) The Contractor’s attention is drawn to the fact that the quantities in these Bills of Quantities are estimated and they are not to be considered as limited or extending the amounts of work to be done by the Contractor.

(g) Irrespective of the requirements contained within the East African Standard method of Measurement it shall be deemed that the contractor has included all requirements contained within the Specification, Drawings, Schedules and Bills of Quantities.

6.1 Particular Instructions

1. Abbreviations used herein will be interpreted as follows: -

ABBREVIATION	MEANING
MM or mm	millimetre
LM or m	metre
m^2	square metre
m^3	cubic metre
kg	kilogramme
No.	Number / quantity

2. Prices given for supply and installation of pipework and ductwork per linear metre or per square metre shall include the supply, delivery and complete installation, including benchwork, painting, ducts, etc, with mechanical joints, unions, brackets and connection pieces, and all other necessary items to leave the installation in a complete and acceptable working order all as specified herein.

3. Sizes given after the item description under the reference “size” shall be interpreted as having millimetre units, unless otherwise specified.

4. The rate entered against each item shall be EXCLUSIVE of all Taxes. The sub-contract works are exempted from the importation duty, VAT and all other Customs Taxes by the Kenya Revenue Authority.

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Special Note: All rates shall be exclusive of ALL Taxes. The sub - contract works are excempted from the import duty, VAT, and all other Customs taxes by the Kenya Revenue Authority				
	AHU TYPE 2 - AHU.01, GROUND, FIRST AND SECOND FLOOR WING A				
	Supply and install a double skinned 100% fresh air handling unit (AHU) complete with a direct expansion (DX) cooler coil unit, utilising low ODP refrigerant and suitable for delivering air with the following characteristics. The AHU to be complete with all the necessary appurtenances such as the air intake, control dampers, insect/bird screen, filter chambers, filters, pressure differential sensors, cooler /heater coil, heat recovery wheel, variable speed fan, pressure sensor and speed controller, duct work connections, access doors, attenuators etc. all suitable for external installation. The heat recovery wheel and AHU to be sourced from the same manufacturing company.				
A	- Air supply and return prefillters: G3; - Air filter: F7 short bag filter; - Air supply flow rate: 3.8 m^3/s @ 600 Pas - Air return flow rate: 2.3 m^3/s @ 400 Pas - Cooler / heater Coil Capacity 60 Kw - Noise break out limited to 40dBA	No	1		
	AHU.02, GROUND AND FIRST FLOOR WING B				
B	Ditto but with the following; - Air supply and return prefillters: G3; - Air filter: F7 short bag filter; - Air supply flow rate: 3.5 m^3/s @ 600 Pas - Air return flow rate: 2.5 m^3/s @ 400 Pas - Cooler / heater Coil Capacity 60 Kw - Noise break out limited to 40dBA	No	1		
	AHU.03, SECOND, THIRD AND FOURTH FLOOR WING B				
C	Ditto but with the following; - Air supply and return prefillters: G3; - Air filter: F7 short bag filter; - Air supply flow rate: 4.2 m^3/s @ 600 Pas - Air return flow rate: 1.0 m^3/s @ 300 Pas - Cooler / heater Coil Capacity 70 Kw - Noise break out limited to 40dBA	No	1		
	AHU.04 & AHU.05, THIRD FLOOR - ICU AND RECOVERY AREA				
D	Ditto but with the following; - Air supply and return prefillters: G3; - Air filter: F7 short bag filter; - Air supply flow rate: 0.6 m^3/s @ 600 Pas - Air return flow rate: 0.5 m^3/s @ 300 Pas - Cooler / heater Coil Capacity 10 Kw - Noise break out limited to 40dBA	No	2		
	AHU.06 -AHU.09, GROUND FLOOR - CHEMO TREATMENT AREA, LINAC ROOM & THIRD FLOOR CSSD				-
E	Ditto but with the following; - Air supply and return prefillters: G3; - Air filter: F7 short bag filter; - Air supply flow rate: 1.2 m^3/s @ 600 Pas - Air return flow rate: 0.8 m^3/s @ 300 Pas - Cooler / heater Coil Capacity 20 Kw - Noise break out limited to 40dBA	No	4		
	AHU TYPE 3 - AHU.3.01 & AHU.3.02, OPERATING THEATHRES				-
F	Supply and install a double skinned re-circulating air handling unit (AHU) complete with a direct expansion (DX) cooling / re-heat coil unit, utilising low ODP refrigerant and suitable for delivering air with the following characteristics. The AHU shall be complete with all the necessary appurtenances such as the fresh air duct connection, fresh and return air regulators, filter chambers, filters, heat recovery wheel, cooler /heater coil, variable speed fans, pressure differential sensors, pressure sensor and speed controller, duct work connections, access doors, attenuators etc. all suitable for external installation. - Air filter: F7 short bag filter; - Air filter: HEPA filter; - Air supply flow rate: 1.5 m^3/s @ 900 Pas - Air return flow rate: 1.0 m^3/s @ 300 Pas - Cooler / Re-heat Coil Capacity: 20 Kw - Noise break out limited to 40dBA	No	2		
	Total Carried Forward to the next Page				

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				-
	Outdoor Units - Supply and Install				-
A	20 Kw VRV heat recovery outdoor condensing unit with inverter compressors, capable of simultaneous heating and cooling as described and located at the roof level, matching the cooler / reheat coils in the AHU Types 2, and 3. The condenser units to be inclusive of the R410 / R134 a refrigerant and the necessary refrigerant pipework including supports, Y junctions, pipework insulation, electrical connections, etc. and any other equipment that may be necessary for completion and satisfactory performance of the system.	No	6		
B	Ditto but 10kW	No	2		
C	Ditto but 70kW	No	3		
	SPLIT AIR CONDITIONERS				
D	10.6 kw (36,000 Btu/h) cooling capacity High Wall Split remote controlled indoor Air conditioner, inclusive of roof mounted outdoor unit complete with support brackets.The unit shall have Auto Restart Operation, drain pump,air filter.It shall operate on R407 refrigerant or any other non ozone depleting refrigerant. Include mounting Brackets as necessary. Sound Power 40dBA.	No.	2		
E	ditto but 7.2 Kw	No.	2		
F	ditto but 5.2 Kw	No.	2		
G	10.6 kw (36,000 Btu/h) cooling capacity DUCTED Split remote controlled indoor Air conditioner, inclusive of roof mounted outdoor unit complete with support brackets.The unit shall have Auto Restart Operation, drain pump,air filter.It shall operate on R407 refrigerant or any other non ozone depleting refrigerant. Include mounting Brackets as necessary. Sound Power 40dBA.	No	5		
H	Refrigeration pipework including insulation for above units	LM	200		
I	Power surge protector for air conditioning equipment with 30 Amps rating	N0	11		
J	32 mm pvc Drainage pipework including bends, tees, U trap and all necessary accessories	LM	150		
	RADIANT HEATER				-
K	600x1200x80mm high ceiling mounted aluminium panel electric radiant heater with built-in thermostat, capable of 600w heat output utilising single phase electrical power, complete with isolating switch located next to the patient bed.	No.	10		
	Extract Fans				
	Ductable cabinet extract fan, manufactured from heavy gauge galvanised steel sheet with double thickness side panels internally lined with 50 mm thick fireproof fiberglass acoustic insulation. The fan to incorporate a static and dynamically balanced double inlet centrifugal impeller, rectangular /circular duct connection flanges, speed controller, on /off switch, sound attenuator to limit the noise level to 40 dB(A), control panel, anti-vibrations mountings, fittings, back draft damper, discharge protection guards complete with bird and insect screens etc. The fan to have the following characteristics:				-
L	-0.2m^3/s at 200 Pa	No	1		
M	-0.4m^3/s at 250 Pa	No.	2		
L	-0.5m^3/s at 300 Pa	No.	1		
N	-0.7m^3/s at 300 Pa	No.	6		
O	-1.0m^3/s at 350 Pa	No.	4		
P	-1.2m^3/s at 350 Pa	No.	1		
Q	-2.0m^3/s at 400 Pa	No.	1		
R	-2.5m^3/s at 400 Pa	No.	1		
S	-3.0m^3/s at 350 Pa	No.	1		
T	Air supply ductwork in galvanised steel sheet including all the fittings and surports, manufactured, fitted and installed in accordance DW 144 standards as described	m^2	3,000		
U	Ditto but return ductwork	m^2	2,000		
V	Ditto but extract duct	m^2	2,000		
	Total Carried Forward to the next Page				

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				
A	The ductwork from and to Air handling units (AHU) shall be Insulated with 40 kg/m3 density polyurethane foam as specified and applied to the ductwork surface and finished off with gauge 22 aluminium cladding as specified, complete with the necessary fasteners, fixtures supports etc.				
B	50mm thick insulation	m^2	2,000		
C	Ditto but 25 mm thick.	m^2	3,000		
D	Approved thickness applied internally to ductwork in accordance with the Specification	m^2	400		
					-
	Stainless Steel Laminar Flow diffusers				-
E	1200 x 600mm laminar flow diffusers capable of 150 l/s air flow rate @ 100 Pa, throw of 1.5 - 2.4m, duct connection 250mm diameter.	No	8		
	Anodised aluminium Slot Flow diffusers				
F	1200mm long slot diffusers capable of 110 L/s air flow rate @ 100 Pa, throw 1.5 - 2.4 and duct connection 250 mm diameter.	No	16		
	Door grilles				
G	350 x 350mm anodised aluminium door grilles capable of 110 l/s flow rate @ 12 Pa, 36dB(A) noise level, colour to Architects approval.	No	140		
	4-WAY DIFFUSERS				
H	4-way anodised aluminium air supply diffuser of the specified sizes, flow rates, pressure loses complete with adjustable **volume controll damper** and finised off to Architects approved colour.				
I	225 x 225mm capable 100L/s @ 24 Pa and 20 dB(A) maximum noise	No	214		
J	300 x 300mm capable 150L/s @ 24 Pa and 22 dB(A) maximum noise	No	95		
K	375 x 375mm capable 250L/s @ 24 Pa and 22 dB(A) maximum noise	No	10		
L	450 x 450mm capable 350L/s @ 24 Pa and 22 dB(A) maximum noise	No	2		
	Anodised aluminium air return eggcrate grilles of the specified sizes, flow rates, pressure loses complete with adjustable volume controll damper and finised off to Architects approved colour as trox or approved equal.				
M	300 x 300mm capable 200L/s @ 10 Pa and 35 dB(A) maximum noise	No.	119		
N	350 x 350mm capable 250L/s @ 10 Pa and 35 dB(A) maximum noise	No.	12		
O	400 x 350mm capable 300L/s @ 10 Pa and 35 dB(A) maximum noise	No.	120		
P	600 x 300mm capable 400L/s @ 10 Pa and 35 dB(A) maximum noise	No.	12		
Q	600 x 400mm capable 500L/s @ 10 Pa and 35 dB(A) maximum noise	No.	2		
R	600 x 450mm capable 600L/s @ 10 Pa and 35 dB(A) maximum noise	No.	5		
	Total Carried Forward to the next Page				

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				
	Extract air disc valves of the specified sizes, flow rates, pressure loses complete with adjustable disc lock nut and powder baked finised to the Architects approved colour.				
A	125mm diameter capable 30L/s @ 70 Pa and 35 dB(A) max. noise	No.	20		
B	160mm diameter capable 80L/s @ 70 Pa and 35 dB(A) max. noise	No.	285		
C	200mm diameter capable 120L/s @ 70 Pa and 40 dB(A) max. noise	No.	9		
	Supply air disc valves of the specified sizes, flow rates, pressure loses complete with adjustable disc lock nut and powder backed finised to the Architects approved colour.				
D	125mm diameter capable 30L/s @ 70 Pa and 35 dB(A) max. noise	No.	8		
E	160mm diameter capable 80L/s @ 70 Pa and 35 dB(A) max. noise	No.	40		-
F	200mm diameter capable 120L/s @ 70 Pa and 40 dB(A) max. noise	No.	6		
	Rectangular ductable counter balanced pressure-relief dampers capable of reliefing the specified flow rate and to maintain the given pressure.				
G	Size 800 x 675 mm capable of 800 l/s flow rate @ 20 Pas	No.	2		
H	Size 400 x 675 mm capable of 500 l/s flow rate @ 20 Pas	No.	4		
I	Size 400 x 345 mm capable of 200 l/s flow rate @ 20 Pas	No.	2		
J	Normally closed motorised damper suitable for (600x500mm) duct installation and capable of 1400 L/S flow rate. The damper shall be interlocked with the space extract fan, the damper to be fully open when the fan is on and fully closed when the fan is off.	No	2		
K	Ditto but (500x450 mm) duct and 1100 L/S flow rate.	No	2		
L	Ditto but (400x350 mm) duct and 800 L/S flow rate.	No.	2		
M	Ditto but (350x350 mm) duct and 700 L/S flow rate	No.	3		
N	Ditto but (350x300 mm) duct and 600 L/S flow rate.	No.	5		
O	Ditto but (300x300 mm) duct and 500 L/S flow rate.	No.	6		
P	Ditto but (300x250 mm) duct and 400 L/S flow rate.	No.	4		
Q	Ditto but (300x200 mm) duct and 300 L/S flow rate.	No.	3		-
	Total Carried Forward to the next Page				

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				
A	Room pressure controlled shut off damper suitable for (800x800 mm) duct installation and 4000L/S flow rate complete with the room pressure sensor iterconnecting control cables and actuator.	No.	1		
B	Ditto but (1100x600 mm) duct and 4000 L/S flow rate	No.	1		
C	Ditto but (750x600 mm) duct and 3500 L/S flow rate	No.	1		
D	Ditto but (500x450 mm) duct and 1500 L/S flow rate	No.	2		
E	Ditto but (500x400 mm) duct and 1000 L/S flow rate	No.	1		
F	Fire damper, 1250mm x 500mm	No	8		
G	Fire damper, 1200mm x 500mm	No	6		
H	Fire damper,700mm x 500mm	No	14		
I	Fire damper, 600mm x 400mm	No	16		
J	Fire damper, 500mm x 400mm	No	18		
K	Fire damper, 400mm x 400mm	No	12		
L	700 x500 volume control damper.	No	4		
M	600 x 400 volume control damper.	No	3		
N	500 x500 volume control damper.	No	14		
O	500 x 400 volume control damper.	No	10		
P	400 x 300 volume control damper.	No	24		
Q	300 x200 volume control damper.	No	30		
R	Sound attenuator, 1250mm x 500 x 1500 mm long	No	8		
S	Sound attenuator, 700mm x 500x 1500 mm long	No	12		
T	Sound attenuator, 500mm x 400x 1500 mm long	No	6		
U	Sound attenuator, 600mm x 400x 1500 mm long	No	6		
	Total Carried Forward to the next Page				

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				
	Flexible Ducts				
A	400mm diameter by 1500 mm long flexible ducting	No	3		
B	Ditto but 350mm diameter	No	7		
C	Ditto but 300mm diameter	No	10		
D	Ditto but 250mm diameter	No	33		
E	Ditto but 200mm diameter	No	70		
F	Ditto but 150mm diameter	No	146		
G	1500mm wide Free standing laboratory Fume cupboard as method series. It should come complete with chemical resistant extract fan, air flow alarm monitors, Flip Open Airfoil For Easy Cleaning Of Spillages, inbuilt wash down system, integral work surfaces and drainage troughs, Automatic Sash Closer etc.	No	4		
	Total Carried Forward to the next Page				-

Item	DESCRIPTION	Unit	QTY	Rate (USD)	Amount (USD)
	Total brought forward from the previous page				-
	Electrical Works				
A	Allow for the electrical works associated with the installation which shall include; - Connecting electrical power from the local isolator to the equipment panel; - Wiring the mechanical equipment motors from the control panel; - Installation of all the mechanical equipment control cables; - Liaising with Electrical contractor for adequate provision of electrical power, etc.	Item	1		
	Supports				
B	Allow for all the necessary supports, including fixings, anchors, insulating blocks and anti-vibration devices	Item	1		
	Identification				
C	Allow for all necessary identification, including plates, discs, labels, charts and colour	Item	1		
	Testing and commissioning				
D	Allow for all necessary testing and commissioning, including flushing, cleaning, purging of air, refrigerant charging, balancing and operating the completed installations and providing the necessary utilities including power.	Item	1		
	Tools and spares				
E	Allow for all necessary tools and spares, including the following:loose keys and - Air Handling Units access panel keys; - One full set of the prefilter, all protected from dust and elements; - One full set of the bag filters, all protected from dust and elements; - One full set of the HEPA filters, all protected from dust and elements;	Item	1		
	Documents				
F	Allow for all necessary documents, including drawings, O&M manuals, as build drawings etc.	Item	1		
	Protective painting and decorative painting				
G	Allow for all necessary protective painting and decorative painting, including removing protective coating or wrapping and cleaning, polishing the exposed surfaces to the Architects /Engineers approval	Item	1		
	Training				
H	Allow for training the Client on the operation and maintenance of the installed systems.	Item	1		
	Total Carried Forward to the HVAC Summary Page				

HVAC-SUMMARY PAGE

Item	Description		Total Cost (USD)
1	Brought Forward from page 6-7 (AC & MV)	……..	
2	Allow for Contingency amount	……..	**50,000**
Total for HVAC installation carried to Form of Tender (Excluding VAT)			

PART 7:
DATA SCHEDULES
KISII CANCER CENTRE - KISII COUNTY, KENYA

PART 7A. EQUIPMENT AND MATERIALS INCLUDED IN THE TENDERED SUM.

AIR HANDLING UNITS

Manufacturer/supplier……

Model details……

Country of supply……

EXTRACT FANS

Manufacturer /supplier……

Model details……

Country of supply……

AIR-CONDITIONING UNITS

Manufacturer /supplier……

Model details……

Country of supply……

DX COOLER COIL

Manufacturer/supplier……

Model details……

Country of supply……

ATTENUATORS

Manufacturer/supplier……

Model details……

Country of supply……

LAMINAR FLOW DIFFUSERS

Manufacturer /supplier……

Model details……

Country of supply……

PRESSURE RELEIF DAMPERS

Manufacturer /supplier……

Model details……

Country of supply……

AIR FLOW REGULATORS

Manufacturer /supplier……

Model details……

Country of supply……

TOILET EXTRACT FANS

Manufacturer /supplier……

Model details……

Country of supply……

SUPPLY DIFFUSERS

Manufacturer /supplier……

Model details……

Country of supply……

EXTRACT GRILLES

Manufacturer /supplier……

Model details……

Country of supply……

AIR TRANSFER GRILLES

Manufacturer /supplier……

Model details……

Country of supply……

DISC VALVES

Manufacturer /supplier……

Model details……

Country of supply……

HEPA FILTERS

Manufacturer /supplier……

Model details……

Country of supply……

BAG FILTERS

Manufacturer /supplier……

Model details……

Country of supply……

PRE-FILTERS

Manufacturer /supplier……

Model details……

Country of supply……

Further Technical literature to be supplied by completing the attached Schedules for all equipment offers.

PART 7B SPECIAL TOOLS REQUIRED

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PART 7C SPARE PARTS LIST OFFERED

AIR HANDLING UNIT .....

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FANS.....

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AIR – CONDITIONING UNITS .....

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OTHERS.....

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PART 7D: SUB-CONTRACTORS TO BE USED

PIPEWORK INSTALLATION……..……..

……

DUCTWORK INSTALLATION……..……

……

ELECTRICAL INSTALLATION……..……..

……

OTHERS ……..……..

……

PART 7E: EQUIPMENT DELIVERY SCHEDULE

AIR HANDLING UNITS ……

COOLER COIL……

FANS……

GRILLES AND DISC VALVES……

AIR-CONDITIONING ……

OTHER EQUIPMENT ……

PART 7. SCHEDULE OF DRAWINGS.

1	M-HVAC-01	GROUND FLOOR PLAN – HVAC LAYOUT
2	M-HVAC-02	FIRST FLOOR PLAN – HVAC LAYOUT
3	M-HVAC-03	SECOND FLOOR PLAN – HVAC LAYOUT
4	M-HVAC-04	THIRD FLOOR PLAN – HVAC LAYOUT
5	M-HVAC-05	FOURTH FLOOR PLAN – HVAC LAYOUT
6	M-HVAC-06	ROOF LEVEL PLAN – HVAC LAYOUT