

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

SUMMARY OF TENDER

AND

SPECIFICATION

**ELLIS WILLIAMS ARCHITECTS
ARCHITECTS**

**ERNEST GRIFFITHS
CONSULTING ENGINEERS**

TENDER ISSUE - FEBRUARY 2022

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

APPENDIX TO FORM OF TENDER

Tenders, on a fully 'Fixed Price' basis, are required.

Any item not specifically described in the Make-up of Tender Price is to be included under the most appropriate heading.

The associated costs of drawings, testing, commissioning, etc., are to be included in all items.

Note that the "Automatic Controls" headings refer to controls specified in Section M9. Other controls are to be included with the items they control.

The following pages are to be completed, signed, and returned with the Form of Tender.

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

BREAKDOWN OF TENDER

A. HEATING AND COOLING

A.1	VRF Heating and Cooling system and Controls	£
A.2	Local Electric Radiators and Controls	£
A.3	Modifications to existing underfloor heating	£
A.4	Re-balancing heating	£
A.5	Setting-to-Work VRF	£
	Section A sub-total carried forward to Summary	£

B. VENTILATION

B.1	Amendments to existing windows and actuators	£
B.2	Installation of new window actuators	£
B.3	Modifications to window controls	£
B.4	Ventilation ductwork modifications	£
B.5	New AHU 1001 and DX system	£
B.6	New Kitchen extract fan system	£
B.7	AHU and ductwork commissioning checks	£
B.8	AHU and ductwork re-commissioning	£
B.9	New AHU setting-to-work	£
	Section B sub-total carried forward to Summary	£

C. HOT AND COLD WATER SERVICES

C.1	Deletion of Lab water services and tank	£
C.2	New hot water generator, cylinder, etc.	£
C.3	Hot and Cold water services for Level 3	£
C.4	Hot and cold water services, excluding Level 3	£
C.5	Cleaning, sterilisation, etc.	£
C.6	Taps and Showers	£
C.7	Final connections	£
C.8	Hot and cold system removals in Block D	£
	Section C sub-total carried forward to Summary	£

D. SOIL AND WASTE SERVICES

D.1	Soil and Waste pipework	£
D.2	Condensate pipework (VRF and AHU)	£
D.3	Final Connections (sinks, basins, etc.)	£
	Section D sub-total carried forward to Summary	£

E. PIPED SERVICES

E.1	Detection of Unit Heaters and associated gas pipework	£
E.2	Revision of gas services to Hot Water Plantroom	£
E.3	New solenoid valve (Hot Water Plantroom)	£
	Section E sub-total carried forward to summary	£

F. THERMAL INSULATION AND TRACE HEATING

F.1	Insulation to ductwork	£	
F.2	Insulation to conventional pipework	£	
F.3	Insulation to refrigeration pipework	£	
	Section F sub-total carried forward to Summary	£	

G. CONTROLS

G.1	Building Management System modifications	£	
	Section G sub-total carried forward to Summary	£	

H. BIG FOOT

H.1	Support system for all roof plant and associated ducts, pipes and cables	£	
	Section H sub-total carried forward to Summary	£	

I. COMMISSIONING

I.1	Setting to work, testing and commissioning	£	
	Section I sub-total carried forward to Summary	£	

J. AS-BUILT DRAWINGS AND MANUALS

J.1	As-Built Drawings	£	
J.2	Operation and Maintenance Manuals	£	
	Section J sub-total carried forward to Summary	£	

K. CONTINGENCY

K.1	Provisional Sum for Additional Engineering	£	25,000.00
	Section K sub-total carried forward to Summary	£	

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

TENDER SUMMARY

A.	HEATING AND COOLING	£
B.	VENTILATION	£
C.	HOT AND COLD WATER SERVICES	£
D.	SOIL AND WASTE SERVICES	£
E.	PIPED SERVICES	£
F.	THERMAL INSULATION AND TRACE HEATING	£
G.	CONTROLS	£
H.	BIG FOOT	£
I.	COMMISSIONING	£
J.	AS-BUILT DRAWINGS AND MANUALS	£
K.	CONTINGENCY	£ 25,000.00
	TOTAL TO FORM OF TENDER	£

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

FORM OF TENDER

DATE:

Sirs,

MANCHESTER COLLEGE, WYTHENSHAW

I/We, the undersigned, hereby tender and offer to manufacture, deliver, erect, test, commission and complete the Works more particularly described and referred to in the tender documentation comprising the General Specification, Mechanical Engineering Services Specification, and Drawings as listed in Section G1, Clause G1.8 all as issued for this Tender and which under the terms thereof are to be designed, manufactured, delivered, erected, tested, commissioned and completed by the Contractor and to perform and observe the provisions and agreements on the part of the Contractor contained in or reasonably to be inferred from the Conditions, Specifications, Drawings, etc., for the sum, exclusive of Value Added Tax of:

(In words).....

.....

(£)

the details of which are given in the Summary of Tender submitted herewith.

I/We further declare that I/we have visited and inspected the Site and have read and understood the tender documents.

I/We hereby undertake, in the event of your acceptance of this Tender, to execute a formal contract embodying all of the conditions and terms contained in this offer within 45 days from receipt of the Letter of Acceptance and if required to furnish a satisfactory Performance Bond in such amount as you may require not exceeding [10%] of the Contract Price and to obtain such insurance as is stipulated in the general conditions of Contract.

FORM OF TENDER - continued

I/We understand that you reserve to yourself the right to accept or refuse this Tender whether it is lower, the same or higher than any other tender, or for any other reason.

I/We agree that this Tender shall remain open for acceptance by you and will not be withdrawn by us for a period of days from the closing date for submission of tenders.

I/We agree should obvious errors be discovered before the acceptance of this offer, these errors shall be corrected in accordance with the "Code of Procedure for Single Stage Selective Tendering" current at the date of tender.

The Contractor is to state here how much notice he will require before commencing the contract works: weeks.

All correspondence relative to this Tender is to be addressed to the undersigned Tenderer at the following address:

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

The undersigned is empowered to sign this Tender on our behalf.

Signed
Name in block capitals
Position
For and on behalf of
Address
.....

Address of registered
office if Limited Company
.....
.....

Date

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

CHARGES WHEN DAYWORK IS ALLOWED

LABOUR

The Contractor shall list below the rates to be applied to all work authorised to be carried out on a Daywork basis.

The rates quoted shall be inclusive of, but not limited to all payments made in respect of Purchaser's Liability, Insurance, National Insurance, Redundancy Payments, Guaranteed Time, Holidays with Pay and Public Holidays, Servicing Time, Supervision, Travelling Time, Fares, Radius Allowance, Tool Money, Periodic Leave, Subsistence Allowance, Transportation of Labour, Bonus or Spot Bonus, Plus Rates, Termination of Employment Clearance Certificate Procedure, Overheads and Profit, any local Agreement applicable, 'lead' money paid to leading tradesmen or chargehands, the use of all tools, plant, etc., the extra cost of imported over local labour, lodging allowance, wages at standard time rates attributable to time lost due to inclement weather, and any emoluments paid for discomfort, inconvenience or risk.

TRADE	GROSS HOURLY RATES				
	NORMAL TIME	TIME AND A HALF		DOUBLE TIME	
		<u>MON-FRI</u>	<u>SAT AM</u>	<u>SAT PM</u>	<u>SUNDAY</u>

Overtime working Premium Times shall be as laid down in the relevant National Agreement.

The gross hourly rates stated above will be applied to the actual hours worked on site.

MATERIALS

The Contractor is to insert here the percentage addition he will require to be added to the cost of materials used on Daywork. The percentage will be added to the nett cost after deduction of all discounts for cash in excess of 2.5% and all trade discounts, rebates and allowances.

Add%

PLANT

The Contractor is to insert below the items of plant and its gross rate per hour or per day that he intends to utilise on the site.

The gross rates inserted shall apply to plant and machinery already on site, whether hired or owned by the Contractor. The rates shall include the cost of fuel, lubricating oils, greases, maintenance, and for licences and insurances applicable to items of plant. They shall not include for drivers or attendants.

The gross rate will be applied to the actual hours worked on Daywork.

The Contractor is to insert the percentage addition he requires to any plant to execute work on Daywork. The percentage shall be applied to the Nett cost of the hire of such plant, and shall include for all overhead charges, profit and other liabilities and obligations.

Add%

Signed

On behalf of

Date

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

PROPOSED LIST OF SUB-CONTRACTORS

Work to be Sub-let

Firm or Company, giving address

1. Ductwork
2. Insulation

Continue list with any other items to be sub-let

Signed

On behalf of

Date

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

COLLUSION

The essence of selective tendering is that the Employer shall receive bona fide competitive tenders from all firms tendering. In recognition of this principle, we certify that this is a bona fide tender intended to be competitive, and that we have not fixed or adjusted the amount of the tender by or under or in accordance with any agreement or arrangement with any other person. We also certify that we have not done and we undertake that we will not do at any time before the returnable date for this tender any of the following acts:

- (a) communicating to a person other than the person calling for the tenders the amount or approximate amount of the proposed tender;
- (b) entering into any agreement or arrangement with any other person that he shall refrain from tendering or as to the amount of any tender to be submitted;
- (c) offering or paying or giving or agreeing to pay or give any sum of money or valuable consideration directly or indirectly to any person for doing or having done or causing or having caused to be done in relation to any other tender or proposed tender for the said work any act or thing of the sort described above.

In this certificate the word "person" includes any persons and any body or association, corporate or unincorporate; and "any agreement or arrangement" includes any such transaction, formal or informal, and whether legally binding or not.

Signed

On behalf of

Date

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

SCHEDULE OF ALTERNATIVE ('OR EQUAL AND APPROVED') MATERIALS

In accordance with Specification this Schedule enables the Tenderer to propose alternative materials to those specified.

Tenderers must however include the specified materials, etc., in their tender.

No alternative will be accepted unless the Main Contractor receives a specific instruction from the Consulting Engineers.

Item (Specify Clause)	Description/ Model Ref.	Manufacturer (or Supplier)	Cost Saving
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continue overleaf, if required ...

SCHEDULE OF ALTERNATIVE ('OR EQUAL AND APPROVED') MATERIALS contd...

Item (Specify Clause)	Description/ Model Ref.	Manufacturer (or Supplier)	Cost Saving
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Signed

On behalf of

Date

MANCHESTER COLLEGE, WYTHENSHAW

MECHANICAL ENGINEERING SERVICES

INDEX TO SPECIFICATION

SECTION M1 - SCOPE OF WORKS

M1.1	GENERAL	M1:1
M1.2	MAIN CONTRACT WORKS	M1:1
M1.3	MECHANICAL AND ELECTRICAL REQUIREMENTS	M1:2
	M1.3.1 BLOCK F - GROUND FLOOR	M1:2
	M1.3.2 BLOCK F - FIRST FLOOR	M1:2
	M1.3.3 BLOCK E - GROUND FLOOR	M1:3
	M1.3.4 BLOCK E - FIRST FLOOR	M1:3
	M1.3.5 BLOCK E - SECOND FLOOR	M1:3
	M1.3.6 BLOCK E - THIRD FLOOR	M1:4
	M1.3.7 BLOCK D - GROUND FLOOR	M1:4
M1.4	EXISTING BUILDINGS	M1:5
M1.5	WORKING AND AS-BUILT DRAWINGS AND OPERATION AND MAINTENANCE MANUALS	M1:5
	Last Page of Section M1	M1:5

SECTION M2 - STANDARD MECHANICAL SERVICES REQUIREMENTS

M2.1	MILD STEEL PIPEWORK	M2:1
M2.2	MILD STEEL PIPEWORK FITTINGS	M2:2
M2.3	COPPER PIPEWORK AND FITTINGS	M2:3
M2.4	PIPEWORK GENERALLY	M2:3
M2.5	ANTI-ELECTROLYTIC COUPLINGS	M2:5
M2.6	PROTECTION OF PIPES	M2:5
M2.7	PIPE SLEEVES	M2:5
M2.8	UNDERGROUND AND BURIED PIPES	M2:5
M2.9	PIPE GRADING, AIR RELEASE, AND DRAINING	M2:6
M2.10	PIPE SUPPORTS	M2:7
M2.11	PIPE EXPANSION AND ANCHORING	M2:9
M2.12	HOT WATER VESSELS, MOUNTINGS, AND FITTINGS	M2:10
M2.13	ALTITUDE GAUGES AND SAFETY VALVES	M2:11
M2.14	THERMOMETERS	M2:12
M2.15	TEST PLUGS	M2:12
M2.16	IDENTIFICATION CODE	M2:14
M2.17	ANTI-VIBRATION PADS	M2:14
M2.18	TESTING AND SCOURING	M2:14
M2.19	OPERATION TESTING AND COMMISSIONING	M2:16
	Last Page of Section M2	M2:17

SECTION M3 - HEATING AND COOLING

M3.1	SYSTEM DESCRIPTION	M3:1
M3.2	GENERAL	M3:3
M3.3	EXISTING UNDERFLOOR HEATING SYSTEM - MODIFICATIONS	M3:3
M3.4	EXISTING REFRIGERANT-BASED HEATING AND COOLING SYSTEM	M3:5
M3.5	NEW VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS	M3:6
	M3.5.1 GENERAL	M3:6
	M3.5.2 REFRIGERANT PIPEWORK	M3:7
	M3.5.3 CONDENSATE PIPEWORK	M3:8
	M3.5.4 VRF SYSTEM	M3:8
	M3.5.5 LOG BOOKS	M3:14
	M3.5.6 WARRANTY	M3:15
	M3.5.7 EQUIPMENT SCHEDULE	M3:15
	M3.5.8 COMMISSIONING	M3:17
	M3.5.9 ROOF-TOP PIPEWORK PROTECTION	M3:17
M3.6	SLEEVES	M3:17
M3.7	PIPEWORK INSULATION	M3:17
M3.8	LOCAL ELECTRICAL CONVECTOR HEATERS	M3:18
M3.9	AIR-HANDLING UNIT HEATING AND COOLING UNITS	M3:19
	Last Page of Section M3	M3:21

SECTION M4 - VENTILATION

M4.1	GENERAL DESCRIPTION	M4:1
M4.2	AIR-HANDLING UNITS - GENERAL REQUIREMENTS	M4:2
M4.3	AIR-HANDLING UNIT - DETAILS	M4:7
M4.4	LOCAL EXTRACT UNITS	M4:9
M4.5	ACTUATOR-OPERATED WINDOWS	M4:9
M4.6	ATTENUATOR AND ACOUSTIC DESIGN	M4:11
M4.7	GENERAL-PURPOSE DUCTWORK	M4:12
M4.8	FLEXIBLE AND BENDABLE DUCTS	M4:18
M4.9	DAMPERS GENERALLY	M4:19
M4.10	FIRE DAMPERS	M4:20
M4.11	SMOKE DAMPERS	M4:21
M4.12	LOUVRES	M4:23
M4.13	DIFFUSERS AND GRILLES	M4:24
M4.14	DUCTWORK SUPPORTS AND BRACKETS	M4:26
M4.16	COMMISSIONING CHECKS ON EXISTING MECHANICAL VENTILATION	M4:27
M4.17	COMMISSIONING OF AIR-HANDLING SYSTEMS	M4:27
M4.18	DIFFUSER AND GRILLE SCHEDULE	M4:29
	Last Page of Section M4	M4:30

SECTION M5 - DOMESTIC WATER SERVICES

M5.1	GENERAL DESCRIPTION	M5:1
M5.2	INCOMING WATER MAIN	M5:2
M5.3	INTERNAL PIPEWORK AND FITTINGS	M5:2
M5.4	INTERNAL VALVES	M5:3
M5.5	INTERNAL STOPCOCKS	M5:4
M5.6	BALL VALVES	M5:5
M5.7	HOT WATER GENERATORS	M5:5
M5.8	COLD WATER BOOSTER SET	M5:6
M5.9	OVERFLOW PIPES	M5:7
M5.10	TRACE HEATING	M5:8
M5.11	HOT WATER BLENDING VALVES AND TAPS	M5:8
M5.12	CONNECTIONS TO WCS	M5:9
M5.13	CONNECTIONS TO SANITARY WARE	M5:9
M5.14	CONNECTIONS TO EQUIPMENT	M5:10
M5.15	PRESSURE TESTING	M5:10
M5.16	INSULATION	M5:10
M5.17	STERILISATION OF PIPED WATER SERVICES	M5:10

Last Page of Section M5 M5:11

SECTION M6 - SOIL, WASTE AND CONDENSATE DRAINS

M6.1	GENERAL DESCRIPTION OF THE WORKS	M6:1
M6.2	PAYMENT OF FEES	M6:2
M6.3	COMPLIANCES WITH REGULATIONS	M6:2
M6.4	LAYOUT OF WORK	M6:2
M6.5	GENERAL REQUIREMENTS FOR PIPEWORK	M6:3
M6.6	SOIL, WASTE VENT PIPES AND STACKS OF CAST IRON	M6:3
M6.7	SOIL, WASTE AND VENT PIPES OF COPPER	M6:4
M6.8	PVC PIPEWORK	M6:5
M6.9	OVERFLOW PIPES	M6:6
M6.10	FLOOR GULLEYS	M6:6
M6.11	WC CONNECTORS	M6:7
M6.12	TRAPS	M6:7
M6.13	PROTECTION DURING BUILDING CONSTRUCTION	M6:8
M6.14	GRADIENTS	M6:9
M6.15	ACCESS FOR MAINTENANCE	M6:9
M6.16	TESTING	M6:10
M6.17	SANITARY WARE	M6:10

Last Page of Section M6 M6:10

SECTION M7 - GAS SERVICES

M7.1	GENERAL DESCRIPTION	M7:1
M7.2	ISOLATING VALVES	M7:2
	Last Page of Section M7	M7:2

SECTION M8 - THERMAL INSULATION

M8.1	GENERAL DESCRIPTION OF WORKS	M8:1
M8.2	HEATING, HOT AND COLD WATER SERVICES	M8:4
M8.3	CHILLED WATER SERVICES	M8:5
M8.4	PIPEWORK GENERALLY	M8:8
M8.5	DUCTWORK	M8:9
M8.6	INSULATED DUCTWORK BRACKETS	M8:10
M8.7	COLD WATER STORAGE TANKS	M8:10
M8.8	HOT WATER VESSELS	M8:11
M8.9	PAINTING OF PIPEWORK BEFORE APPLICATION OF INSULATION	M8:11
M8.10	IDENTIFICATION	M8:11
M8.11	BANNED MATERIALS	M8:11
M8.12	INSULATION THICKNESS TABLES	M8:12
	Last Page of Section M8	M8:19

SECTION M9 - AUTOMATIC CONTROLS

M9.1	GENERAL DESCRIPTION	M9:1
M9.2	STANDARD REQUIREMENTS	M9:3
M9.3	BUILDING MANAGEMENT SYSTEM (B.M.S.)	M9:10
M9.4	VRF HEATING AND COOLING SYSTEM	M9:11
M9.5	LOCAL ELECTRIC HEATERS	M9:11
M9.6	FRESH AIR AND EXTRACT SYSTEM	M9:11
M9.7	AUTOMATIC OPENABLE WINDOWS	M9:14
M9.8	NEW EXTRACT FAN SYSTEM	M9:15
M9.9	HOT AND COLD WATER SERVICE	M9:15
M9.10	FROST PROTECTION	M9:15
M9.11	DAY EXTENSION, ETC.	M9:15
M9.12	DAILY PROGRAMME	M9:15
M9.13	WEATHERPROOFING	M9:16
M9.14	FAULT WARNING	M9:16
M9.15	FIREMAN'S OVERRIDE	M9:16
M9.16	ENERGY CONSUMPTION MONITORING	M9:16
M9.17	COMMISSIONING	M9:17
M9.18	TUNING, TRAINING AND MONITORING	M9:17
M9.19	SUNDRY ITEMS	M9:17
	Last Page of Section M9	M9:17

SECTION M10 - AS-BUILT INFORMATION

M10.1	GENERAL	M10:1
M10.2	REFERENCE TO AS-BUILT INFORMATION	M10:1
	Last Page of Section M10	M10:1

SECTION M11 - ROOF-TOP PLANT SUPPORT

M11.1	GENERAL	M11:1
M11.2	GENERAL ARRANGEMENT OF PLANT SUPPORT SYSTEM	M11:1
M11.3	PIPE, DUCT AND CABLE SUPPORT	M11:1
M11.4	CALCULATIONS AND DESIGN DRAWINGS	M11:2
M11.5	SUPPLIER	M11:2
	Last Page of Section M11	M11:2

SECTION M12 - CONTRACTOR DESIGN

M12.1	GENERAL	M12:1
M12.2	INVESTIGATIONS	M12:1
M12.3	CONTRACTOR DESIGN	M12:2
	Last Page of Section M12	M12:2

SECTION M1 - SCOPE OF WORKS

M1.1 GENERAL

The scope of works for the Mechanical Engineering Services Sub-Contract includes the procurement, co-ordination, installation, testing, commissioning, demonstrating and the subsequent tuning and monitoring of the following, as more fully described in Sections M2 to M11 inclusive.

This Mechanical Specification should be read in conjunction with the General Specification for Engineering Services, the Electrical Specification, and the Main Contract Documents.

M1.2 MAIN CONTRACT WORKS

The Wythenshawe Campus for Manchester College comprises a number of recently built multi-storey blocks, each housing various departments of learning. Block E includes the main reception and provides the external face of the Campus. Block F and Block D form extensions to the rear of the main block in an extended 'C' shape. Blocks A and B are separate buildings within the Campus.

A number of areas with Blocks D, E and F are to be remodelled to provide additional teaching space and to accommodate both the Hair and Beauty Department and the Animal Husbandry Department, which are both to be relocated from their existing locations around the College estate.

Block F, containing a former double height Performance Space, is to be re-modelled with an infill floor to provide classroom spaces at the new upper level and areas for small animal housing and welfare on the lower level. Further animal enclosures are to be added immediately outside this area for certain types of larger animal.

Block E, the large main block including the principal façade of the College is to be remodelled on a number of floors: at Ground level, the existing Learning Resources Centre (LRC) is to be reduced in size, with the recovered area becoming two new teaching areas; at First Floor level, a number of teaching spaces are to be re-modelled for teaching IT; and at Third Floor level, the Hair and Beauty Department is to be accommodated including make-up studios, nail studios and hairdressing salons.

Block D, currently housing various workshop teaching spaces is to be re-modelled within two of the workshops to provide an additional eight classroom-type teaching spaces.

M1.3 MECHANICAL AND ELECTRICAL REQUIREMENTS

M1.3.1 BLOCK F - GROUND FLOOR

The Ground Floor level of the former Performance Space is to be sub-divided into two new teaching spaces for small animal welfare, with a new 'Z'-shaped partition wall.

As the new wall will cut across a number of the existing underfloor heating circuits, this system is to be drained and abandoned with a new air-source heat-pump heating and cooling system being installed. This system is to utilise cassette units within the ceiling void supplying conditioned air to the space via supply-air diffusers.

A mechanical supply and extract ventilation system is to be installed to provide fresh air ventilation to the space, with the air handling unit being placed in the existing roof plant compound.

Other rooms within this block are to be re-modelled, but existing heating, cooling and ventilation arrangements are to be maintained in these areas, with the exception of a new changing room, which is to include a new person-hoist and changing facilities for the less-able.

Mechanical ventilation in this space is to be modified to suit the new use. Note: due to the new location of partitions, the majority of underfloor heating circuits are to be drained and abandoned.

A number of new sinks and basins are to be installed in this area, with new drains directly to below. A new WC is also to be installed in the less-able changing room area. Hot water is to be provided by local instantaneous hot water heaters.

M1.3.2 BLOCK F - FIRST FLOOR

Existing teaching and associated ancillary spaces on this floor are to be retained with existing heating, cooling and ventilation arrangements.

The former Performance Space is to be infilled with a new floor containing two new teaching spaces. These spaces are to be heated, cooled and ventilated in similar fashion to the Ground Floor spaces below, using a common air-handling unit and external condenser plant in the plant space above.

M1.3.3 BLOCK E - GROUND FLOOR

The former LRC area, occupying a large area on the Ground Floor is to be remodelled to include a smaller LRC adjacent to the main entrance, and three partitioned exam and teaching spaces. Construction of partitions for these new spaces will compromise the existing underfloor heating circuits such that they will need to be drained and abandoned in all areas except for the retained open-plan LRC space. New heating and cooling in the form of exposed high-level cassette units, connected to external air-source heat pumps is to be installed throughout these new spaces. Additional wall-mounted radiators are to be installed in the resulting corridor and local office areas.

Ventilation for the new enclosed spaces is to be achieved by reconfiguration of existing automatic opening windows within each of these spaces. Re-modelling is to include the introduction of individual open/shut override controls in each of the spaces.

Former office and administration spaces adjacent to the LRC are also to be remodelled, resulting in the loss of existing underfloor heating circuits to these areas (to be drained and abandoned), and the installation of new VRV heating and cooling.

M1.3.4 BLOCK E - FIRST FLOOR

A number of new IT classrooms are to be installed on this floor.

The existing radiator heating systems in these areas is to be retained, as they are fed from the recently installed air-source heat-pump central heating system. However additional cooling will be required due to the density of computer equipment and students using the space. To provide the requisite additional cooling, cassette units are to be installed at ceiling level: these units are to be connected to new external air-source heat pump units.

The existing automatic openable windows are to be refurbished and retained in operation: no new mechanical ventilation is to be installed for this space.

M1.3.5 BLOCK E - SECOND FLOOR

No new or reconfiguration works are planned for this floor, however, drainage systems and hot and cold water pipework systems for the Hair and Beauty departments above must run through various existing spaces at high level in order to reach suitable discharge points. To accommodate these new drains, minor modifications will also be necessary to other high-level services within certain spaces on this floor.

M1.3.6 BLOCK E - THIRD FLOOR

The majority of the new Hair and Beauty areas are to be heated utilising the existing radiator-based heating system, with no additional cooling systems. Hair salon areas that include use of hairdryers and similar equipment are to receive comfort cooling: this is to be in the form of concealed ducted cassette units, feeding air supply diffusers.

No new ventilation systems are to be installed, except for the nail bar and for the 'reception' area. In general ventilation is to be provided by reconfiguration of the existing automatic openable window system, and reconfiguring existing mechanical systems.

The original science lab ventilation system is to be reconfigured, providing four air changes per hour is to be installed in the nail bar area due to the high concentrations of volatile solvents in these areas.

The existing mechanical ventilation system is to be extended into the reception area, mounted on the 'bridge' overlooking the main entrance to the site. New heating and cooling is also to be provided to this space.

All hair and beauty studios are to include considerable numbers of hand-washing basins that are to be used throughout the day, and hair salons are also to include hair-washing stations. These will require considerable volumes of both hot and cold water. It is understood that the existing hot water provision within the College is insufficient for current use, therefore additional new hot water generating plant is to be installed under this contract.

New drainage is to be installed for the new basins and sinks: this is to drop to high level on the floor below, from where it is to run to existing soil stacks within the building for discharge to outside.

M1.3.7 BLOCK D - GROUND FLOOR

The former painting studio on the Ground Floor of Block D is to be converted into four new 'classroom' type teaching spaces arranged around a central corridor.

The existing direct gas-fired 'unit heaters' are to be removed: new heating is to be provided by wall-mounted radiators to the external walls, with heat being sourced from the new air-source heat pump system. (Note: radiator sizes are large due to the low heat levels from this heat source.) No mechanical cooling is to be installed in these areas.

Existing automatic openable windows on each side of this space are to be reconfigured to provide individual control within each classroom, including the provision of local manual open/closed override controls.

Existing water services are to be stripped-out and drains for the area, including floor gullies are to be stopped-up.

M1.3.8 BLOCK D - FIRST FLOOR

The former refrigeration teaching space on the First Floor of Block D is to be converted into four new 'classroom' type teaching spaces arranged around a central corridor. In addition, the main electrical cupboard, which is within this space, is to be reconfigured as a Staff Room.

The existing direct gas-fired 'unit heaters' are to be removed: new heating is to be provided by wall-mounted radiators to the external walls, with heat being sourced from the new air-source heat pump system. (Note: radiator sizes are large due to the low heat levels from this heat source.) No mechanical cooling is to be installed in these areas.

Existing automatic openable windows on each side of this space are to be reconfigured to provide individual control within each classroom, including the provision of local manual open/closed override controls.

Existing water services are to be stripped-out and drains for the area, including floor gullies are to be stopped-up.

M1.4 EXISTING BUILDINGS

As these works are to be undertaken within existing buildings, care is to be taken at all times to respect the expectation of staff and students to quiet enjoyment of their space: it may, therefore, be necessary for the contractors to restrict certain tasks to 'out-of-hours' times, or to abort 'normal hours' noisy works if required so to do by the College. Any such re-arrangements of works to reduce or avoid disruption are to be accommodated within the Contractor's programme at no additional cost to the Client.

As existing buildings, it is likely that not all of the existing building fabric and installed services will be found to be in precisely the locations shown on the contract drawings. The Contractor is expected to accommodate any changes to the scheme necessary due to these discrepancies within their works at no additional cost to the Client.

M1.5 WORKING AND AS-BUILT DRAWINGS AND OPERATION & MAINTENANCE MANUALS

As part of the works, the Contractor is required to undertake their own detailed surveys of the building to determine locations for connections, etc to existing services, and to route new services to co-ordinate with existing structure and services. The Contractor is required to prepare their own installation and working drawings in accordance with the requirements of the contract drawings, taking into account their survey information.

On completion of the project, the Contractor is to provide full as-built drawings to cover all engineering systems installed or modified under the works. This is to include existing retained systems within the buildings to which connections, etc., have been made as part of the works. A full set of operation and maintenance manuals is also to be provided in accordance with the specification.

SECTION M2 - STANDARD MECHANICAL SERVICES REQUIREMENTS

This Section describes the procedure and/or the methods of installation of plant, equipment, materials, etc., to the Standard Requirements of the Consulting Engineers, and is to apply to this Contract, where appropriate, in extension and amplification of the general intent and meaning of the basic descriptions given elsewhere in this Specification and the associated Drawings.

M2.1 MILD STEEL PIPEWORK

All mild steel pipework is to be run in the quality of tubing later specified with joints, whether screwed, welded or flanged, as stipulated, all to the relevant British Standard. Unless otherwise later specified, pipework of size 50 mm or less to which there is easy access is to be screwed. Other pipework is to be welded.

Screwed joints are to be of British Standard pipe thread, clean threaded and pulled up tight. Joints are to be made with an approved graphite compound and fine threaded hemp or P.T.F.E. tape only. Red lead will not be allowed.

Welded joints are to be in accordance with the requirements of Clause G3.5.

Flanged joints are to be made by screwing on screwed pipework or welding on welded pipework to the ends of the pipes drilled flanges, the flanges to be turned on edge faced full across. The ends of the pipes are to be flush with the face of the flanges.

The two flanges forming a joint are to be flush with one another all round when in position, with all bolt holes in alignment. The joints are to be made with Klingerite or other equal jointing materials, full faced, specially stamped and not cut from sheets on Site, arranged to fit concentrically with the bore of the pipe, and in no way to obstruct the bore of the pipe.

M2.2 MILD STEEL PIPEWORK FITTINGS

(a) Screwed Pipework

Malleable iron long and easy sweep, beaded or banded fittings are to be used for screwed and socketed work. Square tees will not be used except where open vents are taken off, or for non-circulatory branches. Eccentric reducing sockets are to be used where changes in pipe sizes occur. Unions are to consist of two screwed halves, with ground spherical faced joints between the two faces, and one of the two faces is to be of bronze.

(b) Welded Pipework

Tee branches of smaller bore than the bore of the main are to be welded on site, generally, but not without exception, with a "lead" in the direction of the flow, while branches of equal bore to that of the main are to be prefabricated with ends for butt welding to the appropriate British Standard.

Bends are to be purpose-made, seamless, mild steel, of the same grade as the line, with ends for butt welding, while springs and sets are to be purpose-made on the site, cold drawn to a radius of not less than six times the nominal bore of pipes of 50 mm nominal bore and under, and hot bent to a radius of not less than three times the nominal bore of pipes of 65 mm nominal bore and over. In pipes of 80 mm nominal bore and under, the seams are to be arranged along the sides of the springs and sets where possible, or where not possible along the inside radii of springs and sets.

Reducing pieces may either be prefabricated or cut, swaged and welded on Site, with the pieces in either case butt welded into the lines.

Mild steel flanges are to be used for flanged pipework, with welded bosses. Particular care is to be taken to ensure that branch pipes do not protrude into the bore of the main, and that no welding material projects into either of the tubes. The Consulting Engineers may require to inspect any or all of such pipework before it is installed to ensure that these conditions have been complied with.

Sample tests of welds are to be carried out. To be not less than 1% of the welds on the project, nor less than 3 per welder. Results are to be recorded, and submitted to the Consulting Engineers.

M2.3 COPPER PIPEWORK AND FITTINGS

All copper pipework is to be run in the quality of tubing specified, with the joints, whether soldered, screwed, brazed, bronze welded or flanged, as stipulated, all to the relevant British Standard.

Flanged joints are to be made by brazing insert-type flanges, with copper alloy inserts and loose steel locking rings, to the ends of the pipe, otherwise as for steel flanged joints except that brass bolts are to be used.

Joints in the run of pipes of 54 mm O.D. and over, in closed-circuit systems only, may be made by bronze welded butt joints in accordance with the requirements of Clause G3.5.

Bends, sets and springs are to be either prefabricated or cold drawn on Site by machine to a radius of not less than six times the nominal bore of the pipe, while branches are to be connected to gunmetal tees. All bends whether prefabricated or made on Site are to be annealed before fixing in place.

Where light gauge copper tube to B.S.2871 Part I is specified the tube is to be manufactured from de-oxidised arsenical copper to B.S.1174.

Light gauge copper tubes and fittings is to be installed in accordance with the manufacturer's directions and using any special tools or fluxes, etc., recommended.

The use of old or re-drawn copper tube will not be permitted.

Where it is necessary to connect light gauge tube to iron or gunmetal valves or apparatus, straight through adaptors are to be used where the valve or apparatus is screwed and flanged adaptors are to be used where the valve or apparatus is flanged. Flanges are to be to the relevant B.S. Table, installed as described elsewhere.

M2.4 PIPEWORK GENERALLY

All pipework is to be delivered to site in manufacturers' random lengths and straight runs are to incorporate full lengths. No piecings of short cuttings or the use of long screw connections and backnuts will be permitted. All pipework will be left free from excessive tool marks, distortion of section, or other defects.

Pipe jointing is to be non-toxic used with the minimum of P.T.F.E. tape or hemp. All surplus hemp jointing is to be cleaned off threads and fittings before it hardens.

Reducing pieces are to be eccentric unless otherwise specified, and welded or screwed in the lines as applicable.

All ends of pipe are to be reamed before fixing to remove the burr. Particular care is to be taken to ensure that all vertical pipework is parallel with the adjacent walls and at right angles to the walls and ceilings. Any pipes, which in the opinion of the Consulting Engineers are not fixed in accordance with the above, are to be removed and refixed at the Contractor's expense. Generally, pipes are not to be fixed at less than 75 mm clear from ceilings and floors without written sanction to do so from the Consulting Engineers.

The Contractor is to take special care to prevent dirt or rubbish entering the open ends of pipework during erection. Appropriate metal or plastic screwed caps or wood plugs only are to be used to prevent this occurring; plugs of waste or wool are under no circumstances to be used. Should any stoppage in the circulation occur, after the various systems have been put into operation, the Contractor is to attend and rectify the matter at his own expense.

Pipework which is to be insulated is to be fixed in such a manner as to allow each pipe to be insulated around its full circumference, leaving 25 mm minimum between the insulation of any pipe and the finished surfaces of the building or any other pipework, insulation, or other services. Any such pipework incorrectly fixed is to be removed and refixed correctly at the Contractor's expense.

Wherever it is possible to do so, pipework is to be fixed in such a manner that subsequent access to any pipe can be made without disturbing the other pipes. No joints of any kind are to be made within the thickness of walls, floors, or ceilings, or in a vertical duct without permanent access.

In screwed pipework of 50 mm nominal bore and under, unions are to be provided in all cases where they may be required to enable sections of pipework to be subsequently dismantled and refixed without disturbing the building fabric and in any event at intervals not exceeding 12 metres on straight runs. All pipework larger than 50 mm nominal bore/ 54 mm o.d. and all flanged pipework of 50 mm nominal bore and below is to be provided with flanges for the connection of valves, expansion joints, fittings, etc., and pairs of flanges in all cases where they may be required, to enable sections of pipework to be subsequently dismantled and refixed without disturbing the building fabric and in any event at intervals not exceeding 12 metres on straight runs.

All pipework and fittings are to be installed at least 150 mm clear from electric conduits and wiring, after allowing for the thickness of any insulation.

M2.5 ANTI-ELECTROLYTIC COUPLINGS

The Contractor is to provide and fix, between copper pipe and all galvanized steel and mild steel pipework and vessels, non-ferrous couplings of an approved type to inhibit electrolytic action.

M2.6 PROTECTION OF PIPES

All tubes delivered to the site by the Contractor are to be unpainted and are to be given one coat of an approved preservative before despatch. While stored on site care is to be taken to prevent the tubes from rusting and they are to be properly racked and covered, the necessary racks and covers being supplied by the Contractor.

No installed tubing showing evidence of corrosion will be permitted to be put into service.

M2.7 PIPE SLEEVES

In all cases where pipes of any service pass through walls, floors or ceilings, the pipes are to be enclosed by sleeves of similar metal to the pipe concerned, and such sleeves are to be of a size to permit free movement of the pipe and carefully cut to length. The Contractor is to acquaint himself with the nature of the wall finishes, and is to co-ordinate his work with the Main Contractor. A neat finished appearance is required.

Where the wall is fire-resisting, oversize sleeves are to be used, and the annular gap is to be packed with suitable fire-resisting material.

M2.8 UNDERGROUND AND BURIED PIPES

All underground pipes and pipes buried in screed, etc., are to be protected by wrapping in "Denso" tape or other approved corrosion-resisting agent. The requirements of the Water Company relating to such pipes must be strictly observed.

Wherever possible, pipes buried in floor screeds or trenches are to be formed without fittings from one continuous length of tube. Unavoidable fittings are to be welded or soldered, as appropriate. The pipe, after wrapping, is to be laid in, and surrounded by, dry sand.

The whole of the trenches, valves and meter pits, etc., required for the accommodation of underground pipes will be excavated and refilled, or built, by the Main Contractor, and the Mechanical Engineering Contractor is to mark out and accept full responsibility for the correct positioning and detailing of the work.

Should any soft or otherwise bad ground be encountered, all pipes running through it are to be laid on concrete haunching to approved detail. All pipes passing below footings or other foundations are to be similarly protected. The Mechanical Engineering Contractor is to detail any necessary anchor blocks or other builderswork that is required.

M2.9 PIPE GRADING, AIR RELEASE AND DRAINING

All pipes are to be carefully graded to a rise or fall to facilitate the removal of air and for the complete draining of lines for maintenance purposes, and otherwise as specified.

Wherever high points or other air traps occur, the Contractor is to supply and fix an air release unit or 'bottle' comprising a 75 mm length of 32 mm nominal bore pipe with 6 mm nominal bore tube to an air cock fitted in an accessible manner, so that all sections are efficiently vented. In all Plant Rooms, and wherever else specifically noted, air vents are to be of the automatic float type with lockshield isolating valve, discharging to the nearest drain or to atmosphere through a 15 mm copper drip pipe terminated with mitred end.

Automatic air vents are not to be fitted to pipework which may be at negative pressure under certain conditions of service, or at a negative static pressure with all pumps and any pressurising devices turned off. Air 'bottles' as described above are to be provided instead in these locations.

At all low points and on the downstream side of all isolating valves and wherever else shown on the drawings, and elsewhere as necessary to ensure that all sections which may be isolated may also be drained, the Contractor is to provide and fix a 15 mm nominal bore gunmetal drain valve on pipe services of 80 mm nominal bore or less, and 20 mm nominal bore elsewhere except in Plant Rooms where a 25 mm nominal bore gunmetal drain valve is to be fitted.

Drain valves are to be fully in accordance with B.S.2879 and be made by:

Hattersley Ltd.,

or other equal and approved.

M2.10 PIPE SUPPORTS

All pipes are to be supported where shown on the drawings and elsewhere as necessary particularly within 150 mm on each side of all changes in direction and everywhere at intervals not exceeding the following:

(a) Mild Steel Pipes

Nominal Bore	Vertically Fixed (Metres)	Horizontally Fixed (Metres)
15 mm	2.5	1.8
20 mm	3.0	1.8
25 mm	3.0	2.1
32 mm	3.0	2.4
40 mm	3.5	2.7
50 mm	3.5	3.0
65 mm	4.5	3.4
80 mm	4.5	4.0
100 mm and above	4.5	4.0

(b) Copper Pipes

Diameter (o.d.)	Vertically Fixed (Metres)	Horizontally Fixed (Metres)
15 mm	1.2	1.0
22 mm	1.2	1.0
28 mm	1.8	1.2
35 mm	1.8	1.2
42 mm	2.5	1.8
54 mm	2.5	1.8
76 mm and above	3.0	2.5

(c) Plastic Pipes

Diameter (o.d.)	Vertically Fixed (Metres)	Horizontally Fixed (Metres)
Up to 50 mm nominal	1.2	1.1

(d) Generally

Steel pipes of 80 mm nominal bore and under, and copper pipes of 76 mm o.d. and under, having an operating temperature less than 95°C, running singly or in pairs, vertically or horizontally, where exposed to view are to be supported by screw-on-type brackets. Where concealed, and in plantrooms, Unistrut or approved equal may be used.

Build-in brackets are to be of the long shank type while screw-on type brackets are to have a minimum of two fixing screws. In either case, the half hoop to pass round the pipe is to be secured by a single screw.

Brackets are to be of malleable iron for mild steel pipes, galvanized for galvanized pipes and chromium plated for chromium plated pipes. Brackets for copper pipes are to be of cast and not stamped brass.

Steel pipes larger than 80 mm nominal bore, and copper pipes larger than 76 mm o.d., and all multiple runs of pipe are to be supported on angle iron or equal bearers.

All vertical pipes in vertical ducts are to be supported on specially fabricated mild steel brackets supported from the back wall of the ducts. The detail of the brackets proposed to be forwarded to the Consulting Engineers for comment/approval. All copper pipes supported by this type of bracket to be protected from contact with ferrous metal by 'asbestos-free' ring tape 25 mm wide x 6 mm thick.

All pipes likely to operate at 40°C or over and supported by bearer brackets are to be supported from their undersides with cast iron or non-ferrous chairs and rollers. The Contractor may propose alternative sliding support arrangements for consideration.

Wherever hangers or bolts are to be suspended from the soffit where no insert is provided, the hanger or bolt is to be taken through the concrete slab to a 100 mm square backplate with nuts and washers, except in the case of single steel pipes of 65 mm nominal bore and under, and in the case of single copper pipes of 54 mm o.d. and under.

In occupied areas, where pipework is on view, the appearance of brackets and supports is critical, and the Contractor must submit his proposals to the Architect and Consulting Engineers for comment and approval before proceeding.

M2.11 PIPE EXPANSION AND ANCHORING

In the pipework of any service likely to operate at 40°C or over, arrangements are to be made for thermal expansion to be taken up by change of direction or by the installation of expansion joints.

In all cases, free guided movement of pipes is to be maintained and static points are to be arranged between joints by the installation of suitable anchors.

Expansion at changes of direction, expansion joints and anchors are to meet with the following requirements:

The Contractor must ensure that expansion movements do not give rise to noise. Pipes, heat emitters, etc., must be supported on Teflon skids, or hung on swivelling suspension rods, or by other effective means, to eliminate expansion/contraction noises.

(a) Expansion at changes of direction

Wherever this is possible bends are to be opened during erection to the full extent of their cold draw.

Where expansion is planned to take place through a change in the direction of the line of the pipe, 'U' bolt guides are to be omitted on the pipe supporting brackets immediately around the bend, in order to permit lateral movement of the pipe.

(b) Expansion Joints

Expansion joints are to be of the corrugated stainless steel bellows type having outer sliding sleeves and end flanges to the appropriate B.S. Table. All expansion joints are to be compatible with the material of the pipes into which they are fitted.

All expansion joints are to be opened during erection to the full extent of their cold draw, while two suitable purpose-made guides are to be provided on each side of each expansion joint, at spacings as recommended by the manufacturer of the expansion joints, to ensure that expansion takes place in correct alignment.

The greatest care is to be exercised in following the maker's instructions for installation and especially for the hydraulic testing of lines containing expansion joints.

(c) Anchors

Rigid anchors are to be generally similar to the supporting bearers previously specified with the exception that the rollers are to be replaced by a small piece of RS channel shorter in length than the diameter of the pipe and cut to the radius of the outside surface of the pipe.

This RS channel is to be fixed to the supporting brackets and the pipe rigidly anchored by means of 'U' bolts bent to the radius of the outside surface of the pipe and clamped in position with a locknut on the underside of the flange of the supporting bracket. The supporting bracket is to be suitably braced and fixed to the structure so as to withstand rigidly the maximum load imposed upon it. The Contractor is to supply the Structural Engineer with details of the loads on each anchor bracket, and obtain his approval to the design and location of each bracket. The anchor is to be located approximately mid-way between the points at which provision for expansion is made.

M2.12 HOT WATER VESSELS, MOUNTINGS AND FITTINGS

Any hot water vessels to be installed under this Contract are each to be complete with a full set of mountings and fittings which is to include:

- One - Safety valve, spring loaded enclosed type of pattern approved by the National Boiler Insurance Company, "NABIC", complete with padlock and two keys. The discharge from the valve is to be of the same bore as the valve and taken in galvanized medium grade tubing to within 150 mm of the floor, adequately supported and terminated in a splayed end.
- One - Altitude gauge, 150 mm diameter, brass cased, suitably graduated in both Imperial and Metric Units, so that the maximum graduation is not more than twice the working head and complete with manually-set red pointer and gauge cock.
- One - Thermometer, 100 mm diameter, brass cased, vapour pressure type with rigid stem and separable pocket, straight or angle as required, graduated in degrees C with a suitable range of not less than 5°C/105°C, to be installed in the main flow or elsewhere so as to provide a true flow temperature indication. Thermometers are to be Rototherm, or other equal and approved.
- One - Draw-off cock at each low point in the vessel in order that it may be completely drained.

One - Open safety vent pipe taken continuously rising to a sufficient height above the water level of the feed tank to prevent discharge of water from the normal pump head. Where specifically indicated on the drawings a common vent line is to be run for two or more vessels in which case a screwed-down type 3-way valve of a pattern approved by "NABIC" is to be provided at the connection to each vessel with the third port extended in the tubing of the same bore and material as the vent line to within 150 mm of the ground, adequately supported and terminating in a splayed end. (On pressurised systems, alternative arrangements for expansion and safety, as set out in the Water Regulations, are to be provided instead.)

One - Bolted cover to allow full internal inspection of the vessel.

M2.13 ALTITUDE GAUGES AND SAFETY VALVES

The Contractor is to provide and fix to all main flow and return pipes in plantrooms and to hydraulic equipment where specified, and wherever else specified or shown on the Drawings, altitude gauges having a Red line marked on to the scale at the normal static head valve. Scale to be easily visible. Connection to pipework is to be via a gauge cock and syphon.

Where safety valves are specified to be provided in hydraulic systems, the valves are to be of an approved type and be set to relieve all pressure in excess of 1.5 metres head (150 mbar) more than the normal maximum static head.

All static heads are to be determined by site measurement prior to setting altitude gauges and safety valves.

M2.14 THERMOMETERS

The Contractor is to provide and fix 100 mm diameter brass-cased thermometers in the locations listed below, and wherever else indicated on the Drawings or in other clauses of this Specification. Each thermometer is to have a sensing element fitted into a pocket in the pipework, extending at least 50 mm into the pipe. The pocket is to be filled with thermally conductive material and located so as to give a true reading of water temperature. To be Rototherm, or equal and approved. Scale range to be suitable for the fluid concerned, graduated in degrees C.

To be installed, where possible, between 6 and 10 pipe diameters from the associated equipment or point where water flows mix, and with the scale easily visible.

Locations to be:

1. Main flow and return on primary and secondary heating systems in the Boilerhouse.
2. Mixed temperature flow and return in pumped secondary circuits.
3. Chilled water flow and return on each chiller.
4. In chilled water and heating mains at the point of entry into each Plantroom containing plant served by those mains.
5. Wherever else also shown on the Drawings.

M2.15 TEST PLUGS

To assist with commissioning, self-sealing pressure/temperature test plugs are to be fitted in the locations listed below, and wherever else shown on the Drawings or called for in other Sections of this Specification. Each is to be fitted to the side of the pipe to prevent collection of air or scale. Each is to be complete with a screw-on brass cap, and is to be suitable for the fluid in the pipe throughout its range of operating temperatures and pressures.

Test points to be constructed from a single piece of copper alloy body with two Elastomeric cores to provide a dual seal to prevent leakage when withdrawing P/T probes. The cap is to have an "O" ring seal allowing positive finger tightening.

Test points to be Figure 621 "standard" length when fitted directly to uninsulated pipework/components, and Figure 633 "extended" type for insulated pipework/components.

To be manufactured by:

Hattersley.

or equal and approved.

Locations of test plugs to be:

1. Immediately adjacent to all thermostats, temperature sensors, pressure switches and pressure sensors.
2. Adjacent to each port of every automatic control valve, including those fitted to fan-coil units.
3. On the flow side of each self-actuating differential pressure control valve.
4. To measure the mixed flow temperature in every pumped secondary circuit. (Note that this will normally be achieved by the test plug adjacent to the temperature sensor for automatic controls associated with the circuit.)
5. Adjacent to both ports of any characterised valve which is to be used for flow measurement, but which does not have integral test plugs.
6. On the flow and return connections to each heating coil, cooling coil and run-around coil in each air-handling unit, (immediately adjacent to the coil itself).
7. On the suction and delivery connections of every pump.
8. On the flow and return connections of each boiler and each chiller.

Locations are to be at least 2 pipe diameters from the nearest pump flange, valve, or fitting, whenever space allows.

From the time that the systems are put to work, until acceptance of all systems and plant, the Contractor is to keep on site, for use by all parties, thermometers and pressure gauges, all designed for use with the test plugs, in sufficient numbers for commissioning purposes, and not less than two of each.

Thermometers are to be dial type with stainless steel probe, and pressure gauges are to be complete with suitable adaptor probes. This equipment is to be handed to the Employer's Engineer, in good condition, on completion of the project.

M2.16 IDENTIFICATION CODE

All pipes and items of equipment, except those on view in occupied areas, are to be identified in strict accordance with the established Colour Code or with B.S.1710 and are to be further marked for direction of flow. Such identification is to be applied at intervals not exceeding 15 metres, and more frequently as necessary for clarity where any confusion might otherwise exist, including plantrooms (where identification is to be applied to each straight length).

M2.17 ANTI-VIBRATION PADS

Except where higher performance anti-vibration measures are specified, or are necessary to meet the noise limitations specified, the Contractor is to supply only a 25 mm thick 'Ticopad' or equal and approved anti-vibration pad for each pump or other machine which he is supplying under this Contract and which is to be erected on a concrete base. The pads are to be incorporated into the base by the Main Contractor.

Fans and fan motors are not mounted on concrete bases; their supports are specified later.

M2.18 TESTING AND SCOURING

Upon completion, and before insulation, burying or encasing of each section of pipework on all pipework systems, the Contractor is to subject the section to pressure testing and demonstrate to the satisfaction of the Consulting Engineers or other approved witness that the Section is sound.

The testing procedures are to be in accordance with the H.V.C.A. "Guide to Good Practice for Site Pressure Testing of Pipework", published in 1980.

Each witnessed test is to be for a duration of one hour, or such longer time as is necessary to inspect all valves and joints on the section being tested. The decision as to whether or not the section is sound being governed by the rate at which the pressure fails, together with visual inspection of all joints.

All faults discovered during such tests are at once to be remedied by the Contractor at his own cost and expense, and the test re-applied until the Consulting Engineers are satisfied that the section under test is sound.

On completion of the test, the water is to be released and drained completely away as rapidly as possible, the section being then thoroughly sluiced through to ensure the removal of as much dirt and dross as possible before being refilled and put into service.

On lines in which filling points, air release points and drains have not been specified as a permanent feature, they are to be provided by the Contractor to enable the lines to be tested. In these cases, the Contractor is to weld into the crowns and the inverts of the lines at appropriate points 15 mm wrought steel sockets which, on completion of the test, are to be plugged and sealed by welding around the plug.

The Contractor is to include for all drain valves and temporary works necessary to flush out all sections of systems, thus ensuring that the flushing process is effective through all parts of a section of a system. This work will be deemed to include "looping" of flow and return pipework where heat emitters, equipment, etc., are not installed. The recommendations of C.I.B.S.E. and B.S.R.I.A. relating to flushing procedures and chemical/biocide dosing are to be noted and strictly followed, to avoid subsequent problems arising from the water being insufficiently clean and sterile.

The test pressure to be applied to above-ground water pipework is to be 1.5 times the working pressure or 7 bars, whichever is the greater, or as may be later specified for particular special services. Underground pipework is to be tested at twice the working pressure. Other pipework is to be tested to the pressures recommended in the H.V.C.A. Guide referred to above.

Each isolating valve on the system is to be tested for tightness immediately prior to installation. Any valve not found tight is to be dismantled, cleaned and faced as necessary until complete tightness is obtained.

The Contractor is to issue to the Consulting Engineers a Certificate of Test for each section tested, signed by all test witnesses.

The Contractor is to supply and fix as necessary all testing equipment, including the air compressor where relevant and is also to supply all necessary water for testing. The Contractor is responsible for checking whether any components of the system are unsuitable for the full test pressure, and for temporarily blanking off the pipes at the points of connection to those components for the duration of the test.

M2.19 OPERATION TESTING AND COMMISSIONING

In addition to sectional and installation testing, the Contractor is to be responsible for carrying out operation testing of all sections of the contract works; for undertaking associated cleaning, setting, calibrating, adjusting, fully commissioning, demonstrating the commissioning results, and handing over the entire Contract Works in a thoroughly complete and operational state to the Consulting Engineers and the Employer.

Procedure is to be generally as follows:

(a) Ventilation Systems, Heating System, Chilled Water System, Run-around System

The systems are to be commissioned in accordance with the relevant C.I.B.S.E. Commissioning Codes and all B.S.R.I.A. guidance. All control equipment is to be calibrated, set and adjusted to the entire satisfaction of the Consulting Engineers.

(b) Domestic Water Systems

All hot and cold water services before regular use, are to be sterilized generally in accordance with the procedure detailed in the British Standard 6700, or as required by the Local Authority or Water Company.

All draw-off points are to be inspected to ensure efficient operation.

Water temperatures are to be measured at draw-off points to confirm compliance with anti-Legionella recommendations of C.I.B.S.E. TM13.

(c) Plant and Equipment

All plant and equipment is to be commissioned and handed over in a fully operational state, all in accordance with the Manufacturer's recommendations.

(d) Instruments and Control Equipment

All instruments are to be cleaned, inspected and tested under operative conditions and, where necessary or requested by the Consulting Engineers, the Contractor is to call in the Manufacturer of the equipment to ensure that all settings and adjustments are properly effected.

All control equipment whether electrical or otherwise installed as part of the Contract Works is to be commissioned in accordance with the C.I.B.S.E. Commissioning Code, Series 'C', tested under operating conditions by the Contractor, being set, adjusted, calibrated, etc., as necessary, and handed over by the Contractor in first class working order.

Where any such equipment is installed, wired, connected, etc., by other Contractors, it is nevertheless the Mechanical Engineering Contractor's responsibility to ensure its satisfactory completion and operation and to make any necessary arrangements with other Contractors concerned for the completion of their work and responsibilities.

Where equipment is of special or proprietary nature, the Contractor is to arrange for setting, adjusting, calibrating, etc., to be carried out by the Manufacturers and is to include for this work in his Tender Sum.

(e) Other Services

Any other services installed under the contract are to be commissioned as called for in the Section of the Specification in which they are specified or as requested by the Consulting Engineers during the course of the contract.

Attention is drawn to the requirements of Clause G2.10.

SECTION M3 - HEATING AND COOLING

M3.1 SYSTEM DESCRIPTION

Heating and cooling is to be provided by different means in various locations within the building.

Ground Floor, Blocks E & F

The existing heating system on the Ground Floor of Blocks E and F is generally LPHW under-floor. The majority of this system (served by Manifolds M1, M2 and M3) is to be carefully isolated, drained-down and abandoned due to the installation of heavy partition walls. Certain areas, as marked on the contract drawings, are to be retained. Some of the area is heated by existing LPHW radiator systems: these are to be retained.

For each experimental laboratory, heating and cooling is to be achieved by varying the supply air temperature of the air-handling units serving those rooms. Heating and cooling for the air-handling units is to be provided by interlaced direct expansion coils located in the units, with associated condenser units located on the roof.

Existing wall-mounted heating and cooling cassettes are to be retained, where shown on the drawings, with one also being removed.

New heating and cooling VRF units are to be installed to serve the revised LRC and associated teaching spaces, and to serve the Animal Welfare areas. Very small rooms are to receive wall-mounted electric radiators.

First Floor, Blocks E & F

In general, heating and cooling in these areas is to be retained as-is.

New VRF heating and cooling units are to be installed to serve the Staff Area overlooking the Café, and to serve the new classrooms constructed at this floor level over the former theatre.

Second Floor, Blocks E & F

No changes are to be made to the existing heating and cooling systems on this floor, as this area is outside of the contract area (with the exception of drainage, hot and cold water - covered elsewhere).

Third Floor, Blocks E & F

Existing radiators and their associated circuits are to be removed from facades in areas as shown on the contract drawings.

Existing wall-mounted heating and cooling units are to be retained in H&B 1 and H&B 2 classrooms.

New VRF heating and cooling cassettes are to be added to all H&B classrooms and the associated dispensary. In general, these are to be ceiling-mounted units, but wall-mounted units are to be used in the Dispensary (due to space constraints) and in H&B 1 and H&B 2 to match the existing installations.

Block D

In the two new classroom areas in Block D, existing direct gas-fired unit heaters are to be decommissioned and removed from the building, with existing gas pipework cut-back as far as possible to retain service to retained units in other parts of the building.

At Ground Floor level, the new classrooms are to be heated by new LPHW radiators served from the new air-source heat pump 'boilers'.

At First Floor level, the new classrooms are to be heated and cooled by VRF cassette units. The associated Staff Room is to be heated by LPHW radiator, as for the Ground Floor.

External Plant

External plant for the new VRF systems for Blocks E & F is to be located at roof level.

External plant for the new VRF systems for Block D is to be located at ground level in the plant enclosure to the side of the building.

An air-handling unit (described in Section M4) is to be supplied and installed under this contract. The method of heating and cooling for this unit is to be by local DX coils.

M3.2 GENERAL

The Mechanical Engineering Contractor is to supply and install all of the plant and equipment detailed, and is to undertake all testing, balancing, and putting to work all of the new cooling and heating equipment.

Where widths, lengths, and heights are specified, these are indicative only and the Mechanical Engineering Contractor may vary the dimensions to suit manufacturer's standards, providing the heat output of the units is not less than specified.

The Mechanical Engineering Contractor prior to placing any orders must check the space available for each unit so that the unit may be logically accommodated and will not obstruct any access or protrude above window sills, etc. Any unit installed without due regard to this requirement will be required to be replaced without additional payment to the Contractor.

The Main Contractor will prepare all openings, plinths, etc., which may be required. Full details are to be supplied by the Mechanical Engineering Contractor in accordance with the Main Contractor's Building Programme.

This description is given as a summary of the works required, and is not intended to limit the scope of works described in this Specification and/or shown on the Drawings. On completion of the works, the contractor is to hand-over a fully integrated complete system, including all cassette units, ductwork, plenum boxes, grilles, louvres, pipework, insulation, controls, wiring and supports necessary.

All of the refrigerant-based works are to be undertaken by a Mitsubishi-approved Business Solutions Partner, who is to provide a five year warranty (three plus two, subject to maintenance) for the workmanship and equipment.

M3.3 EXISTING UNDERFLOOR HEATING SYSTEM - MODIFICATIONS

An existing underfloor heating system is installed on the Ground Floor of Blocks E and F.

The system comprises four manifolds, each serving a number of underfloor circuits. The layout of these boxes and manifolds is indicated on the tender drawings and is shown in detail on As-Built Drawings U2978M1 and U2978M2 by Responsible Energy Management Ltd, copies of which are included within this tender package. Note: these as-built drawings should be treated as 'for information': the Contractor is to verify that the installations are as shown on the drawings, and is not to rely on the drawings alone.

For each manifold, the works to be undertaken are as follows:

Manifold M4 (Café)

No works are to be undertaken to these circuits, which cover the café and central entrance area.

Manifold M3 (LRC)

All circuits from this manifold are to be carefully isolated and drained down. This includes all of the former LRC area, and the local office spaces opposite. The heating flow and return connections are to be close-coupled at high level in the ceiling void with a regulating valve and metering station to simulate the original flow rate. The manifold is to be completely removed under this contract.

Manifold M2 (Block F Atrium)

One circuit from this manifold is to be retained to serve the atrium area. The other circuit is to be isolated and drained down as shown. The heating circuit serving this area is to be re-balanced to suit the retained single circuit

Manifold M1 (Theatre)

All circuits from this manifold are to be carefully isolated and drained down. This includes all of the former Theatre area and the adjacent former Studio space, as these areas are both to receive new partitions for their revised use as Animal Teaching and Welfare spaces. The heating flow and return connections are to be close-coupled at high level in the ceiling void with a regulating valve and metering station to simulate the original flow rate. The manifold is to be completely removed under this contract.

General

In all cases, each abandoned underfloor heating circuit is to be blown-through with compressed air to remove as much air as possible from the system.

M3.4 EXISTING REFRIGERANT-BASED HEATING AND COOLING SYSTEMS

A number of existing refrigerant-based heating and cooling systems are located in various positions around Blocks E and F. In general, these systems, and all associated pipework, cabling, supports, trays, controls, etc., are to be retained.

The control panel for these systems is in a riser cupboard at First Floor Level in Block F.

Due to reconfiguration of various spaces, a number of individual cassette units are to be removed.

Where cassettes are to be removed, the contractor is to undertake a local survey of the relevant cassette unit(s) and pipework to establish how and where it is connected to the remainder of the system before undertaking any isolation or removal work. Each unit is to be carefully isolated from the system to which it belongs, with refrigerant gas being carefully removed from the cassette and associated pipework as far as the nearest retained system element (BC box, refnet connection, etc). The redundant pipework is to be carefully isolated from the retained system, and the retained system is to be re-charged with refrigerant to leave the remainder of the system operational.

Each unit that is to be removed under the contract is to be removed in its entirety, including all associated local pipework, cabling support tray and basket, hangers, controls, control cabling, etc. The central controller is to be re-programmed to remove reference to this unit.

The locations of cassette units to be retained and to be removed are shown on the contract drawings. If the contractor identifies any additional cassettes, or any deviations from the locations shown on the drawings, these are to be brought to the attention of the Engineer for instruction at the earliest possible opportunity.

Using the as-built numbering, cassette units are to be treated as follows:

Reference	Original Location	New Location	Action
<u>Ground Floor</u>			
IU/07	Studio 1	Staff Room	Retain
IU/08	Control Room	Staff Room	Retain
IU/09	Studio 2	Changing Places	Retain
IU/15	Site Management	Support Learning Kitchenette	Remove

First Floor

IU/11	Studio 2	EEEM 7	Retain
IU/12	Studio	EEEM 7	Retain
IU/13	Studio	Animal Welfare Classroom	Retain

Second Floor

No works to heating/cooling systems on this floor: all units are to remain unaltered.

Third Floor

IU/01	ICT 1	H&B 1	Retain
IU/02	ICT 2	H&B 2	Retain

Each removed unit is to be offered to the College as a potential 'spare'. Any removed refrigerant not re-used on the project is to be disposed of responsibly.

M3.5 NEW VARIABLE REFRIGERANT FLOW (VRF) SYSTEMS

M3.5.1 General

A number of new VRF cassette units are to be installed under this contract, along with external condenser units and all necessary associated supports, tray, pipework, insulation, cabling and controls.

In general, these units are to be installed in areas with no suspended ceiling, so all installations are to be undertaken with the utmost care to provide a neat, tidy and logical installation.

Cassettes are shown in approximate locations for tender purposes. Coordinated ceiling drawings will be required before installation.

The locations of all new indoor and outdoor units are shown on the contract drawings, with schedules also included on the drawings.

The Contractor is to supply and install, commission, and demonstrate a number of heat-recovery VRF heating and cooling systems, complete with all controls, pipework, interconnecting cables, cable tray, insulation, indoor and outdoor units, and all necessary brackets/supports and B.C. controllers utilising R410A refrigerant.

Each VRF system is to have a single twin-condenser outdoor unit which is to be connected to the indoor units via a B.C. controller.

Indoor units to comprise ceiling-mounted cassette units of various types, generally as shown on the tender drawings.

The Specialist Cooling Contractor is to include for supplying and installing galvanised cable and support brackets for all pipework and associated cabling.

All builderswork to be carried out by the Main Contractor. The Specialist Cooling Contractor is to advise the Mechanical and Main Contractor of any builderswork requirements.

M3.5.2 REFRIGERANT PIPEWORK

The Specialist Cooling Contractor is to supply, install, test and commission all interconnecting refrigeration pipe work between the outdoor and indoor units.

Pipework installation is to be carried out by an Approved Mitsubishi Business Solutions Partner company (certificate approval must be submitted prior to installation commencement). The refrigerant engineer assigned to the contract must have an up-to-date Mitsubishi approval certificate (certificate approval must be submitted prior to installation commencement) and must be in accordance with the BSEN 378:2008 (or latest version). Specification and Mitsubishi design and installation instructions. All pipework must be suitable for R410A.

All refrigerant pipework is to be refrigerant quality soft/medium drawn copper tubing to BS EN14276:2007 (or latest version) and is to be complete with the appropriate headers and joints. All refrigerant pipework is to be installed by an Approved Refrigeration Engineer (certificate approval must be submitted prior to installation commencement) in accordance with BS EN378:2008 (or latest version) and the manufacturer's installation instructions.

Longest possible lengths of copper pipe should be utilised to minimise joints on site.

Appropriate refrigeration installation tools must be utilised. Oxygen Free Nitrogen (OFN) must be utilised at all times in the system during brazing.

All refrigeration pipework (suction and liquid lines) is to be insulated with slip-on close cell elastomeric pipe insulation (Armaflex, or equal and approved) with a fire performance class "0" of the 1985 building regulations.

Insulation wall thickness is to be no less than those indicated in the table below, with a thermal conductivity no greater than 0.037W/mK,

Refrigerant Pipe	Minimum Insulation Thickness (mm)
High Pressure	10
Low Pressure	13
HBC to HBC	10
HBC to Indoor Unit	10

After installation of pipework, prior to sealing of insulation joints and starting of equipment, pipework is to be pressure tested as follows in accordance with BS EN378:2008 (or latest version):

Strength Test	= 1.1 x Ps
Tightness Test	= 0.9 to 1.0 x Ps (to hold for a minimum of 24 hours)

Where Ps = Maximum allowable system pressure (Bar)

The Contractor is to confirm with the Manufacturer the maximum allowable system pressure (Ps), and is to see that these pressures are not exceeded.

Refrigerant charge weight must be calculated based on the actual installed length of pipework in accordance with the Manufacturer's recommendations.

Charging must be carried out using appropriate charging scales. Once charging is complete, the F-Gas label on the Outdoor Unit is to be completed to show factory charge, additional charge and total charge.

All pipework is to be properly fixed and supported at a minimum of 1.5 metre centres, but should run fully-supported on galvanised tray wherever possible. All pipework is to be labelled with the system ID number no more than three metre intervals.

Joints in copper pipe are to be brazed. Brazing is to be carried out to the requirements of the HVCA Code of Practice – Brazing and Bronze Welding of Copper Pipe and Sheet.

M3.5.3 CONDENSATE PIPEWORK

A condensate line is to be installed to each fan-coil unit. This is to be installed and insulated all as per the standard specification. Minimum size of condensate pipes to be 25mm ABS plastic gravity from each fan-coil/cassette, drains to run 1:80 min falls as indicated on drawings.

M3.5.4 VRF SYSTEM

Each VRF (Variable Refrigerant Flow) heat-recovery R2 heating and comfort cooling system is to utilise a twin air-cooled condensing unit supplying a number of indoor units. The system is to enable all units to heat or cool independently of the heating or cooling status of other units on the system via a BC controller using only two refrigerant pipes to the indoor units.

Each VRF system is to be complete with a wall-mounted AE200 controller suitable for interfacing with the B.M.S. via a BAC-IP/50 unit for BacNet control. Final location of the AE200 controller is to be agreed on site with the Architect and Engineers

(a) Outdoor Units - PURY-EM250YNW-A1PURY-EP500YNW-A

For each outdoor unit:

The outdoor unit is to be constructed from steel plate and painted with acrylic paint Munsell 5Y 8/1.

The outdoor unit is to have an air cooled heat exchange coil constructed from copper tubing with aluminium fins. The air is being drawn in through three sides of the unit and discharged out of the top of the unit. The R2 system module is to have a single fan mounted on top of each of two coils. The coils are to be capable of being dividing into 20, 30, 50, 70, 80, 100% sections to enable the outdoor unit capacity to match the capacity required by the indoor units.

The outdoor unit module is to have a pair of inverter controlled hermetic scroll compressors capable of controlling the compressor in 1Hz increments.

The refrigeration process for the outdoor unit is to be maintained by pressure and temperature sensors controlling solenoid valves check valves and bypass valves. The heating or cooling mode of the outdoor unit is to be controlled by a four-way valve which is to reverse the cycle of the refrigerant to change the mode of the outdoor unit.

The outdoor unit is to have one discharge pipe which is to supply high pressure liquid, high pressure gas or a combination of both depending on the mode of the indoor units. Refrigerant return to the outdoor unit is to be via one suction pipe. Both pipes are to be insulated.

The system is to be capable of total pipe runs of up to 950m depending on the outdoor model and location of BC box.

The system is to have the following nominal capacity and outdoor unit pipe sizes:

Model	Heating	Cooling	Pipe Sizes	Maximum Indoor Quantity
	(kW)	(kW)		
PURY-EP500YNW-A	31.5	25.1	1.1/8" 1.3/8"	30

The outdoor unit module is to have a 415V AC 3-phase & neutral mains supply and is to have a starting current of no more than 8 Amps. Control is to be via a 30V DC signal generated by the outdoor unit. This signal is to be sent to the indoor units and BC controller via a 2-core non-polar screened cable.

(b) BC Controllers - CMB-M104V-J1 CMB-M1012V-JA1

For each BC controller:

The BC controller is to be constructed from galvanised steel plate partially insulated with polyurethane foam. The base of the unit is to have a foamed polystyrene tray.

The V-J1 master BC controller is to be connected to the outdoor unit via a high pressure and low pressure pipe. The V-J1 master BC controller is to include a gas/liquid separator, which is to separate high pressure liquid and high pressure gas. A brass header pipe with three solenoid valves for each distribution port is to distribute the correct phase of refrigerant to the indoor units.

The BC controller is also to include a tube-in-tube heat exchanger which is to recover waste heat from units in cooling operation and distribute this to units requiring heating. The opposite is to happen in cooling operation.

The refrigeration process in the BC controller is to be maintained by LEVs (linear expansion valves) controlled by pressure and temperature sensors.

The controller is to have 12 ports, allowing a number of blanks for future expansion.

The BC box is to receive a 240V AC mains supply. Control is to be via the 30V DC signal from the outdoor unit.

(c) Indoor Units

Each indoor unit is to have a heat exchanger which is to be constructed from copper tubing with aluminium fins. The flow of refrigerant through the heat exchanger is to be controlled by a linear expansion valve. This valve is to be controlled by two pipe thermistors and a return air thermistor and is to be capable of controlling the variable capacity of the indoor unit between 25% and 100%.

Each indoor unit is to receive a 240V AC mains supply. Control is to be via the 30V DC fuzzy logic signal from the outdoor unit.

There are to be three models of indoor units as follows:

(i) Four-Way-Blow Ceiling Cassette - PLFY-Mxx-VEM-E

Units are to be fixed to the local soffit using a purpose-built frame constructed and installed by the Specialist Sub-Contractor. Units are to draw air from the general open area via a central filtered inlet grille, and to discharge from four variable-direction discharge diffusers. The Specialist Sub-Contractor is to undertake the final fix of units and ductwork to see a vibration-free and leak-free installation.

The units are to be manufactured from galvanised steel plate insulated with closed-cell expanded polyurethane foam, and with a white lower fascia.

Air is to be discharged by an aerofoil bladed centrifugal fan through the four diffusers of the unit into room. Room air is to be returned to the unit through the base of the unit. Return air to the unit is to be filtered through a synthetic fibre washable filter installed in the unit.

Each unit is to have a drain lift up mechanism fitted as standard.

Unit capacities (xx in the product reference above) are to be as scheduled: to be sizes 63, 80 or 100, depending on location.

Each unit is to be complete with a fascia grille type PLP-6EAR1.

(ii) Concealed Ceiling-mounted Units - PEFY-M32xx-VMA-A

Units are to be suspended within a ceiling void **or nominal ceiling void zone**. Each unit is to draw air from within the void and is to discharge via ductwork to swirl diffusers in the face of the ceiling. The specialist sub-contractor is to undertake the final fix of units and ductwork to see a vibration-free and leak-free installation.

The units are to be manufactured from galvanised steel plate insulated with closed-cell expanded polyurethane foam.

Air is to be discharged by an aerofoil bladed centrifugal fan through the front of the unit into the associated supply ductwork. Room air is to be returned to the unit via perforations in the suspended ceiling. Fresh air is to be introduced also to this void. Return air to the unit is to be filtered through a synthetic fibre washable filter installed in the unit.

Unit capacities (xx in the product reference above) are to be as scheduled: to be sizes 32 or 100, depending on location.

The units are to have a drain lift up mechanism fitted as standard.

(iii) Wall-Mounted Indoor Units PCKFY-P63-VKM-ER1

Units are to be fixed to the local wall with a 150mm gap between the top of the unit and the local ceiling. Units are to draw air from the general open area via a filtered inlet grille on the top face, and to discharge from a single face-mounted discharge diffuser. The Specialist Sub-Contractor is to undertake the final fix of units and ductwork to see a vibration-free and leak-free installation.

The units are to be manufactured from galvanised steel plate insulated with closed-cell expanded polyurethane foam, and with a white casing.

Air is to be discharged by an aerofoil bladed centrifugal fan through the front-facing diffuser. Room air is to be returned to the unit through the top of the unit. Return air to the unit is to be filtered through a synthetic fibre washable filter installed in the unit.

The unit is to have a drain lift up mechanism fitted as standard.

(d) VRF Remote controllers - PAR-U02MEDA-K

The controllers are to be wall-mounted and manufactured in ABS plastic with an LCD display and are to be finished in the manufacturer's standard colour. One controller is to be installed in each separately conditioned space.

The remote controllers are to be capable of being hard-wired anywhere onto the Mitsubishi Electric's advanced communication network (M-NET).

The controllers are to be capable of altering the following functions on up to sixteen indoor units (within a group):

- On/Off
- Operating mode
- Setpoint
- Fan speed
- Louvre position (if applicable)
- Timer settings
- Test run

The controllers are also to be capable of displaying the following items:

- On/Off
- Operating mode
- Setpoint
- Return air temperature
- Fan speed
- Louvre position (if applicable)
- Timer settings
- Filter
- Fault diagnosis
- Test run

Set-point range is to be limited to prevent tampering.

All remote controller functions are to be capable of being locked off except for On/Off.

An automatic switch-off timer is to be capable of turning off the unit after a set period (adjustable between 30 minutes to 4 hours).

When units are set in one group, no additional cabling is to be required between indoor units.

Final locations of the controllers to be agreed on site between the Contractor, Architect, and the Consulting Engineer.

(e) Central Controller - AE200

An AE200E Centralised controller is to be provided to enable the viewing, monitoring and control of all Indoor Units and systems connected to the device, to connect to the BMS for other engineering services in the building, and also to connect to other systems and services via the building Ethernet system.

The controller is to have a 10.4 inch Touch colour screen display is to have a resolution of 800x600 and is to be programmed to display plans of the building showing individual unit locations and references.

In addition to controlling the VRF systems, the controller is to be capable of controlling any subsequent Mitsubishi DX systems installed in this area.

The controller is to be mounted in a wall-mounting case, type PAC-YG82TB-J, and is to include a Procon-Melco BEMS interface unit to enable direct connection to the main building Building Management System via Modbus and BacNet connections.

The controller is to provide individual and grouped control of systems and Indoor Units with the following functions:

- On/Off
- Operating mode
- Setpoint
- Fan speed
- Louvre position (if applicable)
- Timer settings (7-day schedule)
- Test run
- Fan mode - Snow (CAHV Only)

The controller is to be capable of monitoring and displaying the following information individually for 50 indoor units:

- On/Off
- Operating mode
- Setpoint
- Return air temperature
- Fan speed
- Louvre position (if applicable)
- Timer settings
- Fault diagnosis
- Water temperature (CAHV Only)
- Ambient Temperature (CAHV Only)

The following local remote controller functions are to be lockable:

- On/Off
- Mode
- Setpoint
- Filter reset

The controller is to provide daily, weekly and annual time schedules; also holiday exceptions and night set-back.

M3.5.5 LOG BOOKS

Full commissioning Log Books are to be supplied free of charge by Mitsubishi Electric through their Business Solutions Partner. These are to be completed fully and included with the main Installation and Operation Manuals prior to handover. In addition, copy pages are to be returned to Mitsubishi at the following address in order that the installation is logged and warranty honoured.

M3.5.6 WARRANTY

The installed equipment has a standard 3 year warranty commencing from the date of commissioning. The Mitsubishi Business Solutions Partner are to offer a further 2 year extension to the standard 3 year warranty providing a maintenance contract is entered into within the first 6 months of completion.

Note for Client: if a maintenance contract is NOT entered into within the first six months, then the equipment will only have a twelve months defect warranty. Maintenance issues are excluded from the 12 month defect warranty.

M3.5.7 EQUIPMENT SCHEDULE

The system is to comprise the following:

Indoor Units:

Ref.	Sys.	Location	Model	Sensible Cooling Load (W)	Comments
1001	A	Support/Learning Kitchenette	PLFY-M40-VEM-E	2900	Ceiling-mounted four-way
1002	A	Staff Work Room	PLFY-M40-VEM-E	2900	Ceiling-mounted four-way
1003	A	FM	PCKFY-P32-VKM-ER1	2000	Wall-Mounted Unit
1004	A	LRC	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1005	A	LRC	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1006	A	Online Exams	PLFY-M63-VEM-E	3600	Ceiling-mounted four-way
1007	A	Quiet Room	PCKFY-P32-VKM-ER1	2200	Wall-Mounted Unit
1008	A	Classroom	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1009	A	Supported Learning	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1010	B	AC Reptile	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1011	B	AC Reptile	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1012	B	AC Specialist	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1013	B	AC Specialist	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1014	B	ACT 1	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1015	B	ACT 1	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1016	B	ACT 2	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1017	B	ACT 2	PLFY-M63-VEM-E	4800	Ceiling-mounted four-way
1018	C	Staff Work Room	PLFY-M32-VEM-E	2500	Wall-mounted
1019	C	Staff Work Room	PLFY-M32-VEM-E	2500	Wall-mounted
1020	C	H&B 3	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1021	C	H&B 3	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1022	C	H&B 4	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1023	C	H&B 4	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1024	C	H&B 6	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1025	C	H&B 5	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1026	C	H&B 5	PLFY-M63-VEM-E	4500	Ceiling-mounted four-way
1027	C	Dispensary	PCKFY-P32-VKM-ER1	2000	Wall-Mounted Unit
1028	C	H&B 1	PCKFY-P63-VKM-ER1	5000	Wall-Mounted Unit
1029	C	H&B 2	PCKFY-P63-VKM-ER1	5000	Wall-Mounted Unit

Ref.	Sys.	Location	Model	Sensible Cooling Load (W)	Comments
1030	D	IT 1	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1031	D	IT 1	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1032	D	IT 4	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1033	D	IT 4	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1034	D	IT 2	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1035	D	IT 2	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1036	D	IT 3	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1037	D	IT 3	PLFY-M32-VEM-E	2900	Ceiling-mounted four-way
1038	D	Classroom 39	PLFY-M50-VEM-E	4100	Ceiling-mounted four-way
1039	D	Classroom 42	PLFY-M50-VEM-E	4100	Ceiling-mounted four-way
1040	D	Classroom 40	PLFY-M50-VEM-E	4100	Ceiling-mounted four-way
1041	D	Classroom 41	PLFY-M50-VEM-E	4100	Ceiling-mounted four-way

BC Controller:

Ref.	Location	Model	Ports	Comments
BC A	FM Lobby	CMB-M1012V-JA1	12	-
BC B	Male Changing	CMB-M1012V-JA1	12	-
BC C	Laundry	CMB-M1012V-JA1	12	-
BC D	To be agreed	CMB-M1012V-JA1	12	-

Outdoor Unit:

Ref.	Location	Model	Refrigerant	Comments
A	Roof Plant Enclosure	PURY-EP400YNW-A	R410A	-
B	Roof Plant Enclosure	PURY-EP400YNW-A	R410A	
C	Roof Plant Enclosure	PURY-EP400YNW-A	R410A	
D	Ground Plant Enclosure	PURY-EP300YNW-A	R410A	

Central Controller

AE200, with Modbus and BacNet interfaces (to be located adjacent to existing controller in Block F).

Room Controllers

PAR-U02MEDA-K

M3.5.8 COMMISSIONING

Commissioning, testing and demonstration of all the equipment is to be carried out by the Specialist Contractor.

All equipment to be manufactured by:

Mitsubishi Electric Europe Air-Conditioning Systems
Manchester

Telephone No. 0161 866 6060

M3.5.9 ROOF-TOP PIPEWORK PROTECTION

All refrigerant pipework, condensate pipework, power supply and control cabling for the VRF system is to be completely enclosed in lidded tray or trunking at roof level and in any other external spaces.

Lids are to be readily demountable for maintenance.

M3.6 SLEEVES

The Mechanical Engineering Contractor is to supply and install sleeves and floor and ceiling plates where pipes pass through walls, floors and ceilings, as specified in Section M2. Sleeves passing through firewalls and barriers are to be suitably packed to maintain the fire rating. Sleeves having acoustic properties are to be as required by Arup Acoustic's Specification.

M3.7 PIPEWORK INSULATION

All refrigerant pipework must, after satisfactory pressure testing, be insulated in accordance with the requirements specified in a later Section of this Specification.

M3.8 LOCAL ELECTRIC CONVECTOR HEATERS

Heating to various small offices and meeting rooms is to be provided by local wall-mounted direct electric convector heaters.

Each heater is to include an integral time clock and thermostat and is to be wired directly to a local fused spur unit.

Individual heaters are to be of the size noted on the contract drawings.

Each heater unit is to include:

- Powder-coated metal chassis (RAL 9016)

- Louvred forward-facing grille

- H-frame wall bracket

- Integral adjustable thermostat, with additional thermal safety cut-out

- Integral seven-day programmable timer with frost protection override

- Single phase electrical supply

To be a type PLXE Panel Heater as supplied by:

- Glenn Dimplex Heating & Ventilation
Millbrook House
Grange Drive
Hedge End
Southampton
SO30 2DF

M3.9 AIR-HANDLING UNIT HEATING AND COOLING UNITS

A new air-handling unit (AHU) is to be installed to serve the Animal Laboratories on the Ground Floor of Block F. Full details of the air-side requirements and configuration of this unit are given in Section M4 of this specification.

With the exception of frost-coils, which are to be direct electric, each air-handling unit is to be heated and cooled by interlaced DX heating/cooling coil, with the size and configuration of that coil varying according to the performance requirements of the particular air-handling unit (AHU). Full details of the individual AHUs can be found in Section M4 of this specification.

Animal Laboratory AHU

Each of these AHUs is to include a main DX heating and cooling coil.

For each unit, the coil is to comprise two refrigerant circuits, fully interlaced. The coil is to include copper tubing with aluminium fins and is to provide at least the level of heating and cooling tabulated at the relevant tabulated airflows.

Each circuit of each coil is to be connected by refrigerant pipework to a separate condenser unit, sized as tabulated, charged with R32 refrigerant. The condenser unit is to a compressor and heat exchanger unit mounted in a common casing with twin horizontal-discharge heat transfer fans.

The unit is to be complete with linear expansion valve, with inverter control for the compressor. Automatic defrost is to be by reverse cycle. The unit is to be suitable for a three-phase and neutral power supply. Maximum dimensions and weights are to be as tabulated.

The unit is to be charged with a refrigerant volume suitable for the design pipework length. Each unit is to be connected to the AHU coil using copper pipework as detailed elsewhere in this Section M3 for refrigerant pipework. All pipework is to be fully insulated.

Criteria	Units	Animal Lab AHU
Coil Output (Heating)	kW	12
Coil Output (Cooling)	kW	12
Number of coils		1
Number of Condensers per coil		2
Condenser Model		PUZ-ZM100YKA.UK
Heating Output	kW	12
Cooling Output	kW	12
Power Supply		3-phase 400V
Max. Current	A	13
Height	mm	1338
Length	mm	1050
Width	mm	370
Weight	kg	125

Air-Handling Unit Interface Module

For each condenser in each AHU, a Mr Slim AHU interface unit is to be supplied and installed. This system is to integrate each of the condenser units associated with a particular AHU with the BMS, and is to undertake step-control of the condensers to the dictates of the BMS. The module is to be capable of full two-way communication via Modbus or Bacnet protocol.

The Specialist Sub-Contractor is to install all of the AHU interface units and is to integrate them fully with their respective condensers, with each other interface unit in the same group, and with the Building Management System. The Specialist Sub-Contractor is to allow for a pre-meeting with the BMS specialist to establish suitable protocols and is to include for commissioning, system integration and system demonstration to the Consulting Engineers and to the Client at Practical Completion

For each AHU, one of the interface units is to be a 'master', and is to be supplied complete with a wireless controller.

Controller		Quantity per AHU			
Type	Model	Animal Lab AHU			
Master	PAC-IF013B-E	1			
Slave	PAC-SIF013B-E	1			

All condenser units and interface modules are to be supplied and installed by a Mitsubishi Business Solutions Partner, with all equipment to be manufactured by:

Mitsubishi Electric
Unit 12, Mercury Park
Trafford Park
Manchester
M41 7LY

Tel: 0161 866 6060

or other Mitsubishi-Approved Business Solutions Partner proposed by the Contractor and accepted by the Engineer.

Full commissioning Log Books are to be supplied free of charge by Mitsubishi Electric through their Business Solutions Partner. These are to be completed fully and included with the main Installation and Operation Manuals prior to handover. In addition, copy pages are to be returned to Mitsubishi in order that the installation is logged and warranty honoured.

The installed equipment has a standard 3 year warranty commencing from the date of commissioning. The Mitsubishi Business Solutions Partner are to offer a further 4 year extension to the standard 3 year warranty.

Commissioning, testing and demonstration of all the equipment is to be carried out by the Specialist Contractor.

SECTION M4 - VENTILATION

M4.1 GENERAL DESCRIPTION

The College is currently ventilated by a combination of openable windows and mechanical ventilation systems. Unless otherwise stated, the existing systems are to be retained for continued use.

Most openable windows are controlled by automatic opening actuators controlled by the BMS. Many of these window actuators appear to be operating erratically at present. The Contractor is to inspect all actuators and is to return them to normal automatic operation. In some areas, controls are to be amended to see that local override controls are installed to reflect new room boundaries. The BMS is to be amended to suit.

A number of ductwork systems are to be amended around the building to suit the new room layouts. Their respective systems are to be re-balanced under the contract.

At Third Floor level, a ventilation system formerly serving science laboratories and prep rooms is to be re-purposed to serve the new Nail Bar area. This system is to be re-balanced under the contract.

A new air-handling unit and ductwork system is to be installed to serve the Ground Floor Animal Welfare area. The unit is to be located in the existing plant area on the roof of Block F.

In general, ventilation rates are to match Building Regulations requirements, however enhanced ventilation rates (4 airchanges per hour) are required for the Nail Bar on the Third Floor and for the Animal Welfare areas on the Ground Floor of Block F (the former Theatre area).

All new ductwork is to be installed neatly, with suitable supports and brackets, and with supply ductwork insulated where running in ceiling voids and risers; and with both supply and extract ductwork fully insulated and clad when running externally.

In a number of areas, as shown on the drawings, additional fire dampers are to be installed.

Re-commissioning and balancing is to be undertaken to all systems amended or otherwise affected by this contract.

M4.2 AIR HANDLING UNITS - GENERAL REQUIREMENTS

New Air-Handling Units are to be supplied, installed, and commissioned complete with all necessary accessories, under this Contract. The Mechanical Services Contractor is to be responsible for positioning the units on supporting channels to be provided under this contract and is to provide 25 mm thick 'Ticopad' or approved equal resilient material to separate the units from the building structure. The 'Ticopad' is to be under the full area of the supporting piers or steels.

(a) General Construction

The unit framework is to be constructed using 50 mm Penta box section, manufactured from 1.2 mm Z5 iron zinc alloy Galvatite steel.

The frame is to be assembled using pre formed corner sections and seam welded internally.

Intermediate post work is to be fitted where necessary to provide a structure of strength and rigidity. The frame is to be capable of supporting the components and fittings forming the air-handling unit and withstanding the pressure within the air system under operating conditions. The frame is to be vapour sealed.

The construction of the units is to be generally double-skinned, of 0.9 mm inner steel sheet, and 0.9 mm outer plastisol coated steel sheet, all pre-galvanised and suitably finished for location externally, on the roof. The 50 mm void between the skins is to be filled with fibreglass for thermal and acoustic insulation. This insulation is to be completely isolated from the airstream. The structure is to be rigid, and is to be designed to prevent any drumming of the panels.

The unit, when assembled in its final location, is to be completely airtight and weatherproof. The unit is to be complete with rolled steel support channels along its full length on both sides, and (if the manufacturer deems it necessary) along its centre line.

The channels are to be not less than 90 mm high, or higher if necessary to enable the condensate drain, after the trap, to gravitate to the outside roof.

The minimum sound reduction indices of the air-handling unit's casing are to be:

Octave Band Centre Frequency

Hz	63	125	250	500	1K	2K	4K
dB	22	11	25	25	31	33	37

This applies to top, bottom, and sides. Joints must be tightly gasketed to prevent any by-passing of the attenuation of the enclosure.

Every unit is to be designed to be bolted together without access to the underside.

A double skinned and insulated construction equivalent to the above, using extruded aluminium Pentapost framework, suitably painted, can be put forward as an alternative.

Under no circumstances is the overall length or height of the air-handling unit to exceed the maximum length and height specified.

Except where otherwise specifically stated, each unit is to be delivered to site in sections to suit the access to the building and the Plant Areas. These sections are to be bolted together in situ, using the manufacturer's standard jointing frames and gaskets. When in transit, sections are to be protected from the weather with heavy-duty polythene; this covering is to be maintained in good repair until the units are finally assembled.

Each unit is to be provided, at the manufacturer's works, with plugged test holes to enable the static pressure differential to be measured across each fan, filter, attenuator, and heating coil.

(b) Fan Section

The fan in each unit is to be capable of providing the specified airflow when the external static pressure is as specified, and when the filters within the unit have a resistance halfway between their 'clean' and 'dirty' resistance. Each filter is to be fitted with an inclined tube magnehelic gauge marked 'Dirty' at the pressure differential included in the air-handling plant performance calculations. Pressure tappings are also to be provided for a pressure differential switch where required in Section M9 of the Specification - Automatic Controls.

Every fan section is to be designed to enable the fan within it to be completely replaced, in sections if necessary, from the 'access side' of the air-handling unit.

Motors for direct-driven centrifugal and plug fans are to have a margin of available power of 25%, at the rated airflow, with dirty filters.

Direct-driven centrifugal and plug fans are to be mounted on a common base frame with the motor.

Vibration entering the structure must be minimised and to this end:

- (i) Every fan's base frame is to be mounted on high-deflection rubber anti-vibration mounts, each anti-vibration mount also having a 'resilient' pad to minimise the transmission of the higher frequency vibrations.
- (ii) The flexible discharge connections on each fan are to be selected and installed so as to minimise by-passing of the anti-vibration mounts. They are to be at least 75 mm long, and straight but not rigid.
- (iii) Fans are to be statically and dynamically balanced.

(c) Filters

Filter Sections are to be equipped with panel type pre-filters and main bag filters, which are side-withdrawable on the 'access side' through a full-height hinged access door.

Filters are to be supported rigidly to prevent distortion of the filter frame even with very dirty filters. Filtration efficiencies are to be not less than that specified at any stage in the life of the filters.

All filters are to be fitted with an inclined tube dial magnehelic gauge, marked as described above.

A spare set of panel filters is to be provided and fitted in each air-handling unit after commissioning and prior to final handover.

(d) Sound Attenuators

Sound attenuators are each to have an air pressure drop of not more than 60 Pa at the rated airflow. They are to be selected by the manufacturer to limit to 10 dB below NR38 the combined noise level anywhere within occupied areas, created by all supply and extract fans running simultaneously. All routes for noise transfer, airborne and structure-borne, are to be taken into account.

Atmospheric-side attenuators are to limit the noise level at 3 metre from the associated louvre, in any direction, to NR 45.

All attenuators are to be faced with material which prevents any shedding of fibres or particles into the airstream. The acoustic material and its facing is to be fire-proof, rot-proof, and vermin-proof.

Splitters which are more than 900 mm long are to have faired leading and trailing edges, not square ends, to minimise the risk of regenerated noise.

(e) Heating Cooling, and Heat Recovery Devices

The coils are to be of the cartridge type, suitable for withdrawal from the unit without disturbing the unit itself. Coil withdrawal is to be from the 'access' side unless otherwise specified.

All coils are to be fully interlaced with the number of separate circuits corresponding to the number of connected condenser units.

All pipe connections are to be screwed or flanged, drilled to PN.16. Flow connections are to be at the bottom, return at the top; the coils are to be designed for contra-flow heat exchange between refrigerant and air. Coils are to be pressure tested at works to 25 bar under water. Coils are to be of copper tubes with polyester coated aluminium fins mechanically bonded to them. Fin spacings are not to exceed 160/metre for frost coils, nor 475/metre for other coils.

The coil sections are to be airtight, and are to make allowance for pipe expansion in their construction. The face velocity of the air across the nett area of any cooling or heating recovery coil is not to exceed 2.5 m/s, and across the nett area of any heating coil is not to exceed 3.0 m/s.

The airside pressure drop of any coils not to exceed 100 Pa.

A galvanised drain tray is to be incorporated into each coil section, and into any heat recovery device, with a single drain connection on the side.

An Eliminator section is to be included if necessary to prevent carry-over of condensed moisture from the preceding coil, under any possible operating conditions. The AHU manufacturer is responsible for ensuring that there is no moisture carry-over and as such will be expected to fit an eliminator section should there prove to be a carry-over problem.

The stainless steel drain tray under each coil and heat recovery device is to extend under the eliminator section (if fitted). The design is to ensure that no water leaks out of the AHU, particularly at the joints between sections. Eliminator plates are to be polypropylene and are to be withdrawable in sections through bolt-on access covers on the 'access' side.

All drainage from each coil, heat recovery device, and eliminator is to comply with the normal requirements of the Health & Safety at Work Executive. All moisture must drain away completely. Each drainage outlet is to be fitted with a transparent trap (by the Mechanical Engineering Contractor). For cases where the air is at negative pressure, the differential between the heights of the inlet and outlet of the trap must be at least 25 mm greater than the maximum negative air pressure in the unit at the point concerned; the crown of the bottom of the trap is to be an equal distance below the outlet invert level.

For cases where the air is at positive pressure, the inlet is to be fractionally above the outlet, and the crown of the bottom of the trap is to be below the invert of the outlet by 25 mm more than the maximum positive air pressure in the unit at the point concerned. Each drain is to be run in 35 mm copper tube, with compression fittings, to the nearest convenient stack, gulley, or external roof with an air-break to prevent back-siphonage.

Each unit is to include a heat recovery cross-over unit with by-pass

(f) Dampers

Where dampers are specified in mixing chambers or otherwise, they are to be complete with linkage and suitable for operation by the number of actuators specified.

Dampers to be constructed of painted galvanised blades and to be fitted with tip and edge seals.

Damper spindle bearings are to be designed to give low resistance to rotation, are to be sealed-for-life, and are to be suitable for perpetual actuation of dampers.

(g) Spacer Plenums

To be incorporated where considered necessary by the manufacturer, in addition to the items in the following clauses.

(h) Diffuser Plenums

Diffuser plenum sections are to be fitted with a diffusing screen to spread the airflow across the full face of the succeeding section. A full-height hinged door on the access side is to give access to both sides of the screen. To be incorporated where specified, and elsewhere as considered necessary by the manufacturer.

To be manufactured by:

Air-Handling Equipment Ltd.,
23 Cotton Street
Liverpool
L3 7DY

Tel. No. 0151 236 3923

M4.3 AIR-HANDLING UNIT - DETAILS

The air-handling unit details are to be in accordance with the General Requirements specified in Clause M4.2, and conform to the following detailed specification:

(a) Animal Welfare AHU 1001

General Arrangement

Double-Deck unit with "supply" on the lower deck and "extract" on the upper deck. Overall dimensions not to exceed 5.2 m long x 1.0 m wide x 1.8 m high (combined height).

Note: Channels may be taller if necessary to enable condensate drain to gravitate, after the trap, to the outside roof.

'Access side' to be on the right, when looking from the centre of the air handling unit towards the supply air discharge end of the air-handling unit.

Lower Deck

Components (in direction of supply airflow)

Inlet Damper	-	Parallel blade suitable for motorised operation (extended spindle). Damper size full face of inlet.
Electric Frost Coil	-	To raise 0.64 m ³ /s from -4°C to +4°C. 7.5 kW 3-phase with step Thyristor control and manual re-set thermal cut-out. Maximum air velocity through heater not to exceed 3.0 m/s over nett face area.
Pre-Filter	-	Panel to G4, with inclined tube manometer.
Main Filter	-	Bag to F7, with inclined tube manometer.
Recuperator	-	Thermal wheel capable of winter heat transfer of 9.5kW with a supply air on-temperature of 4°C, dry bulb and 45% relative humidity to 14°C, dry bulb and 27% relative humidity.
Fan Section	-	Duty 0.64 m ³ /s against a pressure of 300 Pa external to the air-handling unit. Fan(s) to be of the direct driven plug type, motor in airstream. Specific Fan Power to be no greater than 1.0 W per litre/sec. 3 kW 3-phase, inverter controlled.

Heating and Cooling Coil - Two-stage direct expansion, reverse cycle Copper tube coil with aluminium fins. R32. Fully interlaced.
Cooling: entering air at 28°C dry bulb, 29°C wet bulb and leaving at 19°C dry bulb, 16.7°C wet bulb.
Heating: entering air at 13°C dry bulb and leaving at 25°C.

Fan sound power level at the AHU supply outlet not to exceed:

	<u>Octave Band Centre Frequency (Hz)</u>							
Hz	63	125	250	500	1K	2K	4K	8K
SWL(dB) to B.S.848	83	78	79	85	82	79	75	73

Upper Deck

Components (in direction of extract airflow)

Pre-Filter - G4 panel with inclined manometer.

Recuperator - Thermal Wheel

Fan Section - Duty 0.64 m³/s against a pressure of 200 Pa external to the AHU. Fans to be direct driven plug-type with motor in the airstream. Specific fan power to be no greater than 1.0W per litre per second. 2.2 kW.

Exhaust Damper - Parallel blade, suitable for motorised operation (extended spindle). Damper size full face of outlet.

As supplied by:

Air Handling Equipment Ltd
23 Cotton Street
Liverpool
L3 7DY

Their model UE7900

or equal and approved.

M4.4 LOCAL EXTRACT UNITS

A single-fan extract system is to be installed to serve the upper floor teaching kitchen on the Ground Floor of Block E.

The exhaust duct is to have an actuator-controlled damper at the point of exhaust, which are to be closed at all times when the fan is not in operation, and open at all times when the fan is in operation. The unit is to be located as indicated on the drawings.

M4.5 ACTUATOR OPERATED WINDOWS

Ventilation to most areas in Blocks D, E and F within the contract area is provided by actuator-operated openable windows. These units are opened and closed by the BMS.

Under this contract, all existing actuators are to be inspected and returned to full working order (mechanically), and are to be tested and returned to full operational control (electronically) in accordance with the original BMS control regime. All of the actuator-controlled windows within the contract area are marked on the contract drawings (AWxxx): windows outside of the contract area are not labelled and are therefore not included within the contract works.

A number of new windows and actuators are to be added, as detailed on the contract drawings. These are labelled AWxxxx.

A number of new rooms are being created under the contract. Under this contract, each room containing actuator-operated windows is to be modified to include a window operation override switch, which is to command the BMS to override-open, or override-closed the windows in that particular room.

The control routine for overrides is to be as for the existing BMS, with the BMS retaining automatic control at the end of each day.

The unit is to be double skinned with 35mm infill panels, manufactured from heavy-gauge, corrosion resistant Aluzinc steel, internally lined with acoustic material. Fully detachable top or bottom panels for maintenance/service and manometer test points. It is to include a direct-drive EC motor to provide the most energy-efficient solution conforming to part L regulations. Fans are to have a 5 year warranty.

The unit is to be controlled by an integrated Ecosmart control panel mounted to the fan unit and is to include: integral frequency inverter/speed controller; integral adjustable run-on timer; maximum and minimum speed adjustment/setting (trickle and boost); volt free run & failure/status indication; 0-10V BMS interface for remote operation; low voltage interface with second fan or supply fan; multiple low voltage sockets for interconnection of sensors or fans; and background ventilation/trickle enable switch.

Duty is to be as follows:

Volume: 0.060 m³/s

External Resistance: 100 Pa

Model: AVTS1

with integral room-side and atmosphere-side attenuators: AVS1-MSS

Specific Fan Power to be no greater than 0.6 Watts per l/sec.

As supplied by:

Nuaire
Western Industrial Estate
Caerphilly
CF83 1NA

M4.6 ATTENUATORS AND ACOUSTIC DESIGN

(a) Rectangular Duct-Mounted

All attenuators, in ductwork, are to be provided and installed by the Mechanical Services Contractor. They are to be selected to achieved the specified noise limits (see Clause M4.2(d)), at a pressure drop not exceeding 50 Pa.

All attenuators are to be faced with material which prevents any shedding of fibres or particles into the airstream. The acoustic material and its facing is to be fire-proof, rot-proof, and vermin-proof. The casing of attenuators is to be galvanised sheet metal of thickness not less than that of the associated ductwork, with flanged connections; spigot connections may be used on minor ducts, or where space constraints make them necessary.

Splitters which are more than 900 mm long are to have faired leading and trailing edges, not square ends, to minimise the risk of regenerated noise.

(b) Crosstalk Attenuators

Crosstalk attenuators are to limit the intelligibility of sound passing between rooms. The average Sound Reduction Index (SRI) of each attenuator is to be not less than 30 dB.

The SRI performance relates only to the attenuator, and they are not to take into account the additional attenuating effect of ceiling voids, ductwork, etc.

(c) Fire-Rated Attenuators

Attenuators on the car park extract ventilation system are to be capable of operating in a fire-rated situation of 300°C for one hour. If the acoustic infill dissolves, it must be contained within the splitter and must not impede the fan's performance during the period of high temperature.

(d) General

The attenuator dimensions as indicated in the schedules and/or shown on the drawings are preliminary; manufacturer's dimensions may differ. If the Mechanical Engineering Contractor wishes to alter the dimensions of any attenuator to enable a particular manufacturer's products to be used, he is first to check that the change(s) do not create installation, co-ordination, or access problems, and is then to seek approval from the Consulting Engineers. Change-section pieces are to be provided as necessary upstream and downstream of each attenuator, to match the attenuators selected, at no additional cost.

Attenuators to be manufactured by:

IAC Ltd
Second Floor Westbrook House
Westbrook Way
Warrington
Cheshire
WA5 8UH

Telephone No. 01925 653 423

or equal and approved.

Acoustic Design

All noise and vibration control measures for all Mechanical Services systems (including pumped systems) are to be independently verified by an acoustic expert, employed by the Mechanical Engineering Contractor, at an early stage in the Contract, to ensure that suitable plant, equipment, attenuators, etc., are ordered. A detailed report is to be obtained from the expert, and forwarded to the Consulting Engineers.

For the avoidance of doubt, it is stressed that the provision of suitable plant, equipment, attenuators, supports, etc., to meet the performance criteria, and the verification by an acoustic expert are the responsibility of the Mechanical Engineering Contractor, and no variation in the Contract Sum will be allowed in respect of these items.

M4.7 GENERAL-PURPOSE DUCTWORK

Ductwork manufacturing drawings must be submitted for approval prior to installation.

Unless otherwise specifically stated in this Specification, or noted on the drawings, ductwork is to be in accordance with the requirements of the Heating and Ventilating Contractors Association's Standard Specification for Sheet Metal Ductwork, DW/144, published in 1998.

The information required in Part 1 of DW/144 is as follows:

2.1 Pressure Classification

To be determined by Contractor during detailed design.

2.2 Leakage Classification

All supply and extract ductwork systems associated with AHUs: Class B

All other ducts: Class A

Note that joints to terminal units, attenuators, etc., are to be to the same standards. Any leaks giving an audible noise in occupied areas are to be stopped.

2.3 Positive and Negative Pressures

Within limits of Table 1 of DW/144

2.4 Materials

Unless otherwise noted on the drawings, or stated in this Specification, all ductwork is to be made from hot-dipped galvanised sheet, to B.S.EN10142:1991, Grade DX51D+Z, Coating type Z275.

2.5 Any Special System Requirements

None other than those specified and shown on the Drawings.

3.1 Access Inspection Openings

To be as Section 20 of DW/144, except as modified by the following requirements:

Note that the term "Access Door", or "Access Panel", "A.D." or "A.P.", as used on the drawings is synonymous with the term "Access Panel" as used in DW/144, unless the Drawings or this Specification require the Access Door to be hinged. Hinged Access Doors are to be similar, but with hinges on one vertical side, wedge-type latches, and a compressible gasket all round so as to be airtight. Any openings required beyond those called for by DW/144 are to be as shown on the drawings. Access openings in insulated ducts are themselves to be of insulated double-skin construction.

Additionally, access panels are required, for cleaning and inspection purposes, at intervals of not more than 12 metres on all header ductwork, (and at least one between each consecutive pair of obstructions such as elbows, dampers, etc.), and in each branch duct (unless it has an open end). All access panels unless otherwise noted on the drawings, are to be 450 mm x 375 mm, or as near to these dimensions as the duct size and location permits.

Where access openings are used by personnel for entering the duct, the duct's floor is to be reinforced to take the weight of a person.

The Mechanical Services Contractor is to ensure that access openings are carefully located to co-ordinate with associated builderswork access apertures, ceiling grids, etc.

Test holes for pressure measurement are required in the locations given in Clause 20.6 of DW/144, and also:

- (i) upstream and downstream of every fan.
- (ii) upstream and downstream of every filter, (in addition to the points of connection of the filter's manometer).

Test holes for velocity scans, (and similar holes for velocity/temperature scans), are required to enable all the following to be measured:

- (i) the total airflow handled by each fan.
- (ii) the total airflow in each branch.
- (iii) the total airflow and temperature profile entering and leaving any heating or cooling coil.

Test holes for velocity measurement are to be in accordance with Clause A3.1.6 of the C.I.B.S.E. Commissioning Code, Series A.

Exact locations of test holes are to be determined by the Mechanical Services Contractor's Commissioning Engineer, to achieve the most accurate readings.

3.2 Cleaning Access

See 3.1 above

3.3 Regulating Dampers

As called for by this Specification, and/or the Drawings.

3.4 Fire Dampers

As called for by this Specification, and/or the Drawings.

3.5 Smoke Dampers/Combination Smoke and Fire Dampers

As called for by this Specification and/or the Drawings.

3.6 Bendable/Flexible Ducts

As described for by this Specification and/or the Drawings.

3.7 Flexible Joints

At all connections to fans and as called for by this Specification and/or the Drawings, in accordance with Section 26 of DW/144, (except where higher requirements are indicated on the Drawings).

4.1 Air Leakage Testing

All ductwork in accordance with DW/144 Appendix 'A' for the leakage class(es) stated in item 2.2 above (except fan-coil unit discharge ducts, which need not be tested).

4.2 Protective Finishes

Ductwork which is to be galvanised after manufacture is noted as such on the Drawings. To be in accordance with DW/144 Appendix 'E', and B.S.729.

Damaged areas of any galvanising, if acceptable to the Consulting Engineers, shall be made good in accordance with Clause 27.31 of DW/144. If not acceptable, the ductwork section shall be replaced.

4.3 Fire-rated and Smoke Extract Ductwork

Where ductwork is specified or shown on the Drawings as being constructed or enclosed so as to be fire-resistant, it is to be encased by the Mechanical Engineering Contractor (unless the Drawings state that the fire-rated enclosure is to be by the Main Contractor). The fire-rated encasement is to comprise 'Conlit' or other approved proprietary materials, applied in full accordance with the manufacturer's recommendations, to achieve the required fire resistance, and the finished result is to be to the satisfaction of the Local Authority's Building Control Officer.

4.4 Internal Thermal/Acoustic Lining

Refer to detailed Specification clauses.

4.5 Thermal Insulation

To be supplied and fitted, in accordance with a later Section of this Specification - Thermal Insulation:

Insulation with inherent vapour seal must be provided on supply ductwork within plantrooms, fresh air intake ductwork, and fan-coil units' discharge ducts and plenums.

Ductwork conveying cooled air must have the vapour seal continuous through brackets and supports, using hardwood bearers equal in thickness to the insulation, with the vapour barrier between the bearer and the support/bracket.

4.6 Special Supports

As specified elsewhere in this Specification and/or shown on the Drawings.

4.7 Attachment to Building Structure

As specified elsewhere in this Specification and/or shown on the Drawings.

4.8 Air Terminal Units

Air Terminal Units are to be required by this Specification and/or as shown on the Drawings.

If not otherwise specified or indicated on the Drawings, it may be assumed that ceiling-mounted grilles or diffusers which are rectangular or circular, and which will fit into a nominal 600 mm x 600 mm aperture in the ceiling grid, will be supported by the ceiling grid, but connecting ductwork (whether rigid, bendable, or flexible) must be independently supported. All other types of grilles and diffusers, (including linear diffusers) must be provided with independent supports.

4.9 Ductwork Layout Drawings

No special requirements, but the Drawings must give sufficient details to allow the Mechanical Engineering Contractor to ensure co-ordination of services.

4.10 Other Requirements

Turning vanes are to be provided in rectangular ductwork wherever the duct direction changes by 30° or more by means of a square bend. For changes of direction between 30° and 80°, single-skin blades shall be used. For 81° to 90° changes of direction, double-skin proprietary vanes shall be used. In all cases, the leading and trailing edges of the turning vanes are to be parallel to the duct as it enters and leaves the bend. Vanes shall be free from sharp edges or other sources of noise.

Unless otherwise specifically shown on the drawings, radius bends without splitters are in all cases to have a 1D throat radius. 0.5D throat radius fittings are not to be used without the express agreement of the Consulting Engineers, and then only where lack of space renders a 1D throat radius impractical.

All ducts except those on view in occupied areas, are to be identified with symbols complying with Appendix "B" of DW/144. Symbols are to be at intervals not exceeding 6 metres, and more frequently as necessary for clarity where confusion might otherwise exist.

Ductwork is to be run generally parallel with walls and ceilings with not less than 100 mm space between wall, ceiling or floor and finished face of duct. During fabrication and installation the ductwork is to be kept free of debris, rodents, etc., with all openings sealed with strong plastic sheet or similar at all times when work is not in progress. On completion it shall be cleaned down both outside and inside (where practicable) by brushing, vacuum cleaning, use of grease and oil remover, etc., before commissioning.

Any ductwork with an aspect ratio of more than 3:1 is to be constructed of 1.6 mm thick sheet (or thicker, if required by DW/144).

All branches are to have a 'shoe' (unless coned branches are specifically shown on the Drawings).

Transitions are to be as gradual as possible within the physical limitations.

Where the requirements of this Mechanical Engineering Specification exceed those of DW/144, this Mechanical Engineering Specification is to prevail.

M4.8 FLEXIBLE AND BENDABLE DUCTS

Flexible or bendable ducts are to be used only as scheduled below.

Where flexible or bendable ducts are installed, they are to comply with the insulation, airtightness, and pressure testing requirements that apply to the rigid ductwork system of which they form a part.

Flexible and bendable ducts must be stored and handled with care to prevent distortion or damage. Any bends in the ducts as installed must have a minimum throat radius of one duct diameter.

Supports are to be so spaced as to prevent sagging or vibration of the ducts. The length of each section of flexible duct is to be kept to the minimum necessary to enable the ductwork to be installed.

Locations of bendable ducts are as follows:

Interconnections from fan-coil units to the supply air diffusers, where indicated on the Drawings.

uPVC or non-metal flexible ducts are forbidden.

Flexible and bendable ducts, when tested to B.S.476, Parts 6, 7, and 8, are to meet the requirements of CP.413 Section A2.2.3.

To have a Class 1 spread of flame rating to B.S.476, Part 7, and to have a fire integrity of 15 minutes to B.S.476, Part 8.

Joints to ductwork and equipment are to be made with sealant and blind rivets in accordance with the manufacturer's instructions, ensuring that no sharp edges are presented to the airstream.

Metal bendable ducts are to be made from spirally-wound aluminium strip. Metal flexible ducts are to be made from multi-ply aluminium for maximum flexibility consistent with the fire resistance. To be supported with the manufacturer's type OBO brackets, complete with neoprene liners. Support spacings not to exceed 1.0 metre. Bendable ducts to be Regaduct type PAK, or equal and approved. Flexible ducts to be Regaduct type AL, or equal and approved.

At the Mechanical Services Contractor's option, bendable ducts may be factory-insulated to the standards specified later. If so, joints at ends must be carefully close-butt and vapour-sealed, and the finished thickness of the insulation must achieve the specified requirements.

To be as manufactured by:

Rega Metal Products Ltd.,
Eldon Way
Biggleswade
Bedfordshire
SG18 8NA

or equal and approved.

M4.9 DAMPERS GENERALLY

Balancing Dampers, (generally denoted "B.D." or "V.C.D" on the drawings), are to be opposed-blade, multileaf dampers, with spindles horizontal (unless this would result in the damper being awkward to operate). Dampers on circular ducts not exceeding 150 mm diameter may be single-leaf butterfly dampers.

Wherever possible, dampers are to be prefabricated, with aerofoil section blades, which have a resistance to airflow not exceeding 5 Pa when the blades are fully open and the air velocity across the full face of the damper is 5.0 m/s. Multi-leaf blades are to be made of stainless steel with spindles supported in free-running long-life bearings. Linkage to be outside the airstream. Butterfly blades are to be stainless steel or galvanised. Degree of opening of damper to be indicated, and damper position to be lockable. Damper frame to be airtight and robust. Connections to square or rectangular ducts to be flanged. Connections to circular or flat-oval ducts to be spigotted.

Every spigot on extract ductwork, through which air is extracted from ceiling/roof voids, is to be fitted with a Balancing Damper of the type specified above.

Where ducts incorporate separate dampers on either side of a mid-feather, or if the location of the duct precludes the incorporation of a pre-fabricated damper, custom made dampers are to be installed. These are to have double-skinned galvanised steel blades and are to be in accordance with DW/144.

Any Isolating Dampers, (generally denoted 'I.D.' on the drawings), are to have aerofoil section stainless steel blades, which have a resistance to airflow not exceeding 8 Pa when the blades are fully open and the air velocity across the full face of the damper is 5.0 m/s. Air leakage when the damper is closed is not to exceed 20 litres/sec/m² damper face area when the pressure differential across the damper is 1000 Pa. In other respects to be as specified for Balancing Dampers.

To be manufactured by:

Actionair Equipment Ltd.,
South Street
Whitstable
Kent
CT5 3DU

Advanced Air (UK) Ltd.,
3-4 Cavendish Road
Bury St Edmunds
Suffolk
IP3 3TE

Gilberts Ltd.
Gilair Works
Clifton Road
Blackpool
FY4 4QT

or equal and approved.

M4.10 FIRE DAMPERS

Fire Dampers, (generally denoted 'F.D.' on the drawings), are to be of the curtain type, with shutter blades constructed of stainless steel, and are to provide a 2-hour fire resistance. The shutter is to be spring-loaded to ensure positive closure, and the fire damper is to be operated by an integral fusible link, rated at 68°C - 74°C. The damper casing is to be completely airtight. When closed, the ends of the shutter blades are to be sealed with a flexible stainless steel gasket on the inside face of the frame.

Unless otherwise specified or noted on the drawings, all fire dampers are to have their blades clear of the airstream when open, and are to have no projections into the airstream.

To be Actionair type 201,301, or 401, as appropriate, (or Advanced Air's, or Gilberts' equivalent, or equal and approved).

Each fire damper is to be complete with the manufacturer's installation frame, which is to comply with of DW/144. Where no ductwork is to be connected, the dampers are not to be fitted with ductwork spigot connections on the side(s) on which ductwork is not required.

To be manufactured by:

Actionair Equipment Ltd.,
South Street
Whitstable
Kent
CT5 3DU

Advanced Air (UK) Ltd.,
3/4 Cavendish Road
Bury St Edmunds
Suffolk
IP3 3TE

Gilberts Ltd.
Gilair Works
Clifton Road
Blackpool
FY4 4QT

or equal and approved.

Fire dampers to allow the passage of air through cavity barriers in ceiling voids are to be installed by the Mechanical Services Contractor, with rigid support from the soffit, before the cavity barriers are installed by the Main Contractor. These fire dampers do not need installation frames where no ductwork is connected, but are to have flanges to which the cavity barrier can be attached.

Fire Dampers in apertures greater than 1 metre wide are to consist of an assembly of two fire dampers, the joint being fitted with the manufacturer's closure strips on both sides.

Fire Dampers in Roof Plantroom walls and floors are to be installed as indicated on the detail on the Drawings. The mineral wool is to be close-packed to avoid any paths through which noise from the plantroom can reach the floor below. The steel frame and angle are to be provided by the Mechanical Services Contractor.

M4.11 SMOKE DAMPERS

Smoke Dampers, (generally denoted 'S.D.' on the drawings), are to be of the curtain type, with shutter blades constructed of stainless steel, and are to provide a 2-hour fire resistance. The shutter is to be spring-loaded to ensure positive closure, and the smoke damper is to close on loss of power to the motor. Power is to be removed from the motor by activation of duct smoke sensor. The damper casing is to be completely airtight. When closed, the ends of the shutter blades are to be sealed with a flexible stainless steel gasket on the inside face of the frame.

In 'normal' mode, the motor is to remain energised and is to power open and hold open the damper.

Unless otherwise specified or noted on the drawings, all smoke dampers are to have their blades clear of the airstream when open, and are to have no projections into the airstream.

To be Actionair type HS2501/PTC HotShield with spring closure and motor opening, (or Advanced Air's, or Gilberts' equivalent, or equal and approved).

Each smoke damper is to be complete with the manufacturer's installation frame, which is to comply with of DW/144. Where no ductwork is to be connected, the dampers are not to be fitted with ductwork spigot connections on the side(s) on which ductwork is not required.

To be manufactured by:

Actionair Equipment Ltd.,
South Street
Whitstable
Kent
CT5 3DU

Advanced Air (UK) Ltd.,
3/4 Cavendish Road
Bury St Edmunds
Suffolk
IP3 3TE

Gilberts Ltd.
Gilair Works
Clifton Road
Blackpool
FY4 4QT

or equal and approved.

Smoke dampers to allow the passage of air through cavity barriers in ceiling voids are to be installed by the Mechanical Services Contractor, with rigid support from the soffit, before the cavity barriers are installed by the Main Contractor. These smoke dampers do not need installation frames where no ductwork is connected, but are to have flanges to which the cavity barrier can be attached.

Smoke Dampers in apertures greater than 1 metre wide are to consist of an assembly of two fire dampers, the joint being fitted with the manufacturer's closure strips on both sides.

Smoke Dampers in Roof Plantroom walls and floors are to be installed as indicated on the detail on the Drawings. The mineral wool is to be close-packed to avoid any paths through which noise from the plantroom can reach the floor below. The steel frame and angle are to be provided by the Mechanical Services Contractor.

M4.12 LOUVRES

The Mechanical Services Contractor is to supply and install external weather louvres as indicated on the drawings and to perform in accordance with the schedules.

The louvres are to be designed to prevent the ingress of driving rain, both when the fans are running and when they are idle. Louvres to be aluminium extrusions, complete with a flanged aluminium frame, and drip sill at the bottom. A galvanised birdscreen is to be fitted to the inside face. Unused louvre areas are to be blanked internally and insulated. The vertical pitch of the blades is not to exceed 100 mm. The louvres are to be silent in operation and free from vibration resonances induced by the wind or the airflow.

The air pressure drop with a face velocity of 2.5 m/s is not to exceed 50 Pa. The exact sizes are to be determined on site or by reference to the Architectural drawings, as appropriate, by the Mechanical Services Contractor before ordering. The louvres are to be finished in stoved acrylic paint or with a polyester powder coating or approved equal. Colour is to be to a B.S. colour selected by the Architect. Fixing to be through the sides, with stainless steel screws parallel to the blades, not through the face of the flange.

To be manufactured by:

Gilberts Ltd., Blackpool

Greenwood Airvac Ltd.

Solid Air Ltd.

or equal and approved.

Any remaining louvres located in plantroom walls are to be provided by the Main Contractor. The Mechanical Services Contractor is to include for airtight connections to them ensuring that the intake and discharge connection sizes comply with those indicated on the drawings.

At each airtight connection, the Mechanical Services Contractor is to include for a galvanised birdscreen fitted to the inside face of the louvre.

Unused louvre areas are to be blanked off internally and insulated by the Mechanical Services Contractor. (Refer to the Architect's drawings for positions and quantities.)

M4.13 DIFFUSERS AND GRILLES

Diffusers and grilles are to be provided where shown on the Tender Drawings, and as scheduled generally of the types as follows. Note: Most areas of the building have no suspended ceilings, with exposed services (referred to below as 'open' ceilings); certain areas are to have suspended ceilings. In each case the grilles and diffusers are to be suitable for their particular ceiling type.

Ventilation systems which are to be retained in areas covered by this contract are shown on the tender drawings with their diffusers and grilles referenced by their original reference numbers. In general, these are SG/xxx or EG/xxx (where xxx is a number in the series 001-999).

New grilles and diffusers are denoted on the drawings by references SG/xxxx or EG/xxxx (where xxxx is a number in the series 1001-1999). In addition, certain doors are to include air-transfer grilles which are denoted as TG/xxxx.

All supply diffusers, door transfer grilles and extract grilles are to receive a polyester powder coat finish, White to RAL 9010, or an alternative 'stock' colour advised by the Architect. The required colour is to be confirmed with the Architect prior to ordering.

(a) Open Ceiling Supply Diffusers

Square Vertical Discharge

To be four-way blow, type DG4, with plenum. Generally to be 200mm x 200mm, unless otherwise stated on the drawings or schedules

Circular Horizontal Discharge

To be double deflection diffuser, type HHV (horizontal blades nearest to the room), with plenum. Generally to be 200mm x 200mm unless stated otherwise on the drawings or schedules.

(b) Suspended Ceiling Diffusers

To be four-way blow, type DG4, with plenum. Generally to fit into a single ceiling tile space.

(c) Open Ceiling Return Air Grilles

To match supply diffuser types

(d) Suspended Ceiling Return Air Grilles

To match supply diffuser types.

(e) Air Transfer Grilles (Door-mounted)

To be type FB700, with a grille face on each side of the door, and with an intumescent fire damper integral to the unit. To be 536mm wide x 152mm high (nominal size) unless otherwise detailed on the drawings or in the schedules.

All to be as manufactured and supplied by:

Gilberts (Blackpool) Ltd.,
Gilair Works
Clifton Road
Blackpool
Lancashire
FY4 4QT

or equal and approved.

Generally

All grilles and diffusers, with their dampers, etc., are not to regenerate noise which causes the mechanical services to breach the specified noise limits. Additionally, the radiated sound power levels (dB re. 10^{-12} watts) from any grille or diffuser, at the design airflow, is in any event not to exceed:

	<u>Octave Band Centre Frequency (Hz)</u>						
	125	250	500	1K	2K	4K	
In Toilets	50	42	39	35	32	30	dB
In all other Areas	43	35	32	28	25	23	dB

M4.14 DUCTWORK SUPPORTS AND BRACKETS

Ductwork throughout the building is generally to be equipped with supports in accordance with DW/144.

Tenderers are advised to inspect the Architectural and Structural drawings, to ensure that they obtain sufficient knowledge of any trimmer steels, etc., that they may need to provide in order to support the ductwork.

Ductwork which passes through plantroom walls or floors, if not equipped with fire- or smoke-dampers, is to be provided with an acoustically packed sleeve. Where fire- or smoke-dampers are fitted, the acoustic packing is to be as specified under Fire- or Smoke-Dampers in this Section.

It should be particularly noted that wherever supply ductwork has vapour-proofed insulation, supports for that ductwork must accommodate the vapour barrier.

M4.15 ACTUATOR-OPERATED WINDOWS

Existing openable windows are opened and closed automatically by electric actuators controlled by the existing Building Management System (BMS).

Under this contract, all of the actuator-controlled windows marked on the drawing with a reference AWxx (where xx is a number reference between 01-99) are to be inspected, overhauled and set-to-work. Any actuators found to be inoperable are to be identified to the Engineer for possible replacement under the contract.

A number of newly created rooms require new or additional actuator-operated windows. These are marked on the drawings AWxxxx (where xxxx is a reference number between 1001-1099). In each case, an actuator is to be added, with a corresponding power supply and a new connection is to be made to the BMS.

Where partitions have moved, or are moving, since the original installation, local manual override controls are to be added such that each individual room containing actuator controlled windows has an independent means of overriding the BMS operation.

M4.16 COMMISSIONING CHECKS ON EXISTING MECHANICAL VENTILATION

At the outset of the contract, the Mechanical Contractor is to undertake a full commissioning check of each of the following air handling units and their associated ventilation systems both to prove operation of the air-handling unit and to see that the systems are appropriately balanced in accordance with the original installation scheme.

The Contractor is to report these findings to the Engineer at the earliest opportunity in order to provide time for any changes to the specified works that need to be instructed as a result.

System schematics and commissioning data for the original systems are available within the tender package.

AHU 1 - Block F Performance Suite

AHU 2 - Block E Science Labs

AHU 5 - Block E General Extract System

EF 2 - Block E Toilet Extract System

M4.17 COMMISSIONING OF AIR-HANDLING SYSTEMS

Commissioning of all air-distribution systems, both supply and extract, in all areas, is to be carried out by the Mechanical Engineering Contractor in accordance with the C.I.B.S.E. Commissioning Code, Series 'A', and all results are to be recorded. Where possible, dampers on supply air systems are to be adjusted so that the dampers on the 'index' run are fully open, (the final adjustment of volume flowrate being achieved by alteration of the fan speed or, in the case of axial flow fans, by adjustment of the pitch of the fan blades). Dampers are to be adjusted to achieve the required balance with minimum re-generated noise.

If the regulation of the dampers on any final branches of the office fresh air ductwork cause the overall noise level in any part of the office area to exceed NR38, then the Mechanical Engineering Contractor is to fit perforated plate to the ends of any offending branches, to enable the dampers concerned to be opened to near fully-open. The perforated plate is to be fixed inside an end cap which has a suitably sized concentric hole cut out of the flat end, to form a circular angle ring which is fixed to the end of the duct with mastic and rivets. The commissioning programme is to allow time for this 'tuning' work. The Tender Sum is to include the cost of complying with this requirement; for tendering purposes it should be assumed that there will be 10 final branches to be 'tuned' in this way, per floor, (i.e. 40 total for the whole project).

The airflows from fan-coil units are to be adjusted to achieve the airflows scheduled, using the fan speed controllers on the units. In each case, the airflow is to be equally divided between the diffusers served by the fan-coil unit, and the speed is to be adjusted so that the damper serving the least-favoured diffuser is fully open.

Each fan-coil unit's airflow is measured, adjusted and demonstrated using appropriate calibrated hoods and a vane anemometer. The calibrated hoods are to collect the air discharging from the supply air diffusers and, via suitable transformations, pass the area through a known cross-sectional area where its velocity can be measured. The design and calibration of the hoods are to be determined when the fan coil airflows are tested under laboratory conditions. Airflow measurements using laboratory calibrated hoods are then to be repeated on each diffuser of each fan-coil unit during the commissioning phase of the project.

When the Mechanical Services Contractor is satisfied that all systems are working satisfactorily, and when the commissioning records are available, he is to offer the system for witnessing and acceptance.

The Mechanical Services Contractor is also to demonstrate that each fan, heater battery, etc., meets all the requirements of the Specification.

Any systems which are found to be at variance with the Specification are to be re-adjusted and corrected before being offered again for acceptance. The Employer and the Consulting Engineers reserve the right to charge the Mechanical Services Contractor at their normal hourly rates for the time abortively spent in witnessing systems that prove to be unacceptable.

M4.18 DIFFUSER AND GRILLE SCHEDULE

Supply Diffusers

Reference	Block & Floor	Location	Airflow	Type	Height	Width
			l/s		mm	mm
SG1001	F 3	Nail Bar		HHV	200	200
SG1002	F 3	Nail Bar		HHV	200	200
SG1003	F 3	H&B 3		HHV	200	200
SG1004	F 3	H&B 3		HHV	200	200
SG1005	E 1	EEEM 7		HHV	200	200
SG1006	E 1	EEEM 7		HHV	200	200
SG1007	E 1	OFFICE		HHV	200	200
SG1008	E 1	IT 1		HHV	200	200
SG1009	E 1	IT 1		HHV	200	200
SG1010	E 1	ACT 1		HHV	200	200
SG1011	E 1	ACT 1		HHV	200	200
SG1012	E 1	ACT 2		HHV	200	200
SG1013	E 1	ACT 2		HHV	200	200
SG1014	E 0	AC SPEC 1		HHV	200	200
SG1015	E 0	AC SPEC 1		HHV	200	200
SG1016	E 0	AC SPEC 2		HHV	200	200
SG1017	E 0	AC SPEC 2		HHV	200	200

Transfer Grilles

Reference	Block & Floor	Location	Airflow	Type	Height	Width
			l/s		mm	mm
TG1001	F 3	Dispensary		FB700	152	356
TG1002	F 3	H&B 5		FB700	152	356
TG1003	F 3	H&B 2		FB700	152	356
TG1004	F 1	Meeting Room		FB700	152	356
TG1005	F 1	Meeting Room		FB700	152	356
TG1006	F 1	Staff Room		FB700	152	356
All transfer grilles to be double-sided with integral intumescent fire dampers						

Extract Grilles

Reference	Block & Floor	Location	Airflow	Type	Height	Width
			l/s		mm	mm
EG1001	F 3	Nail Bar		HHV	200	200
EG1002	F 3	Nail Bar		HHV	200	200
EG1003	F 3	H&B 5		HHV	200	200
EG1004	F 3	H&B 5		HHV	200	200
EG1005	F 3	H&B 3		HHV	200	200
EG1006	F 3	H&B 3		HHV	200	200
EG1007	F 3	Dispensary		HHV	200	200
EG1008	F 1	Staff Room		HHV	200	200
EG1009	F 1	Staff Room		HHV	200	200
EG1010	F 1	TT 1		HHV	200	200
EG1011	F 1	TT 1		HHV	200	200
EG1012	E 1	ACT 1		HHV	200	200
EG1013	E 1	ACT 1		HHV	200	200
EG1014	E 1	ACT 2		HHV	200	200
EG1015	E 1	ACT 2		HHV	200	200
EG1016	E 1	Office		HHV	200	200
EG1017	E 0	AC SPEC 1		HHV	200	200
EG1018	E 0	AC SPEC 1		HHV	200	200
EG1019	E 0	AC SPEC 2		HHV	200	200
EG1020	E 0	AC SPEC 2		HHV	200	200
EG1021	F 0	Facilities Man.		HHV	200	200
EG1022	F 0	Kitchen Hood		Hood	200	200
EG1023	F 0	Kitchen		HHV	200	200
EG1024	F 0	Counselling		HHV	200	200
EG1025	F 0	1 : 1		HHV	200	200
EG1026	F 0	Staff Room		HHV	200	200

Note: all airflows and sizes are to be confirmed with the Engineer before ordering.

SECTION M5 - DOMESTIC WATER SERVICES

M5.1 GENERAL DESCRIPTION

Domestic water services under this project are to be part-extensions of existing systems and part-new systems.

The Hair and Beauty Department, to be located on the Third Floor of Block E is to include many workstations for various treatments, including basins, hair washing stations and pedicure baths. These stations are all to be fed from a new service, including a new hot water generator to be located in the rooftop Hot Water Plant Room.

All other areas of the development, including various teapoints and similar outlets, and all of the outlets in the Animal Welfare Area are to have supplies derived from existing hot and cold water services.

Prior to installation of the new systems, an existing water supply feeding former laboratory spaces on the Third Floor of Block E is to be removed, along with all associated pipework.

Various water services in Block D are also to be removed to allow for installation of new classrooms in that area.

Pipework for each system is to be installed in copper, with both hot and cold water services insulated throughout their length in all plant areas, risers and ceiling areas (whether above suspended ceilings in voids, or in areas having no suspended ceiling), except where on show running down walls in occupied areas such as kitchens, WCs and laboratories.

The works within this Section of the Contract are to include:

1. Isolation and removal of former special water distribution system to former laboratories on Level 3 of Block E
2. Isolation and removal of general water services to various areas in Block D
3. Extension of existing hot and cold water services to deliver to outlets on the Ground Floor and First Floor.
4. Installation of a new hot water generator in the rooftop Plant Room.
5. Installation of new hot and cold water services from the rooftop Plant Room to serve the Hair and Beauty department.

6. The provision of new external water services for animal welfare.
7. The supply and installation of insulated hot and cold water service pipework to all areas, including final connections to sanitary fittings and local blending valves to reduce the water temperature at the taps and showers.
8. Testing, commissioning, demonstrating and setting to work the various systems.

The whole of the works to be complete with pipework, brackets, supports, stop-cocks, cold water storage cisterns, control valves, insulation etc., all as specified and/or indicated on the Contract Drawings.

All pipework and general matters are to be in accordance with the requirements set out in Section M2.

The foregoing description is for general guidance, and is not intended to replace or limit the more detailed information given in the Specification and/or on the Drawings.

M5.2 INCOMING WATER MAIN

No amendments are required to the incoming water main under this contract.

M5.3 INTERNAL PIPEWORK AND FITTINGS

All internal tank, hot, and mains water service pipework is to be installed in light gauge copper tube to B.S.2871 Part 1 Table X.

All fittings for copper pipework are to be of the lead-free capillary type fittings, deemed to be suitable for potable water supply conforming to B.S.864: Part 2.

All fittings as manufactured by:

I.M.I. Yorkshire Ltd.

or equal and approved.

All fittings, valves, etc., must be of the type NOT subject to DEZINCIFICATION.

All exposed pipework, fittings, brackets and valves serving Toilet areas are to be as the above but chrome plated.

M5.4 INTERNAL VALVES

(a) Isolating Valves

Isolating valves on hot and cold water supplies in concealed locations to be of the non-dezincifiable copper alloy wedge gate type, with non-rising stem incorporating handwheel or lockshield as required, being in accordance with B.S.5154. End connections to be capillary or compression as required.

All as manufactured by:

I.M.I. Yorkshire Ltd.

or equal and approved.

(b) Servicing Valves

Individual 'servicing valves' are to be provided as required by the Water Regulations. To be screwdriver -operated quarter-turn ball valves, of a type not subject to dezincification, suitable for potable water systems, and to the approval of the Water Company. To have compression fittings. Not to be used on pipes larger than 22 mm; stopcocks to be used instead.

Manufacturer: Hattersley Newman Hender

or

I.M.I. Yorkshire Ltd.

or equal and approved.

(Note particularly that budget-priced alternative makes are generally not as reliable in the long term and are unlikely to be approved.)

(c) Service Valves to WC Cisterns

A different type of servicing valve is to be fitted to the final branch pipe to each WC cistern. The valve is to incorporate a strainer, and the design is to comply with the requirements of the Water Regulations for water supplies to cisterns having internal overflows. To be constructed of materials which are not subject to dezincification.

To be manufactured by:

Cottam & Preedy

their CP961 Multi

or equal and approved.

(d) Solenoid Valves to WC Cisterns

All connections to WCs are to incorporate solenoid valves on the BCWS connection to isolate the supply when the toilet areas are unoccupied. These are to be controlled via a PIR sensor within in each Male, Female and Accessible Toilet and Shower Room.

M5.5 INTERNAL STOPCOCKS

The Mechanical Services Contractor is to provide and install stopcocks to each water service as called for in the Specification or indicated on the Drawings.

Each stopcock is to be in accordance with the requirements of B.S.1010 and to be of the screwed down type with renewable disc suitable for the service temperature of the line and with double union ends. Stopcocks to be as manufactured by I.M.I. Yorkshire Ltd., and must be of the type NOT subject to DEZINCIFICATION.

M5.6 BALL VALVES

Equilibrium ball float valves

The Contractor is to supply and fix, to control the water supply to Basement break tank cold water cisterns, Ball Valves suitable for the maximum pressure of the line, and complying with the current Water Regulations. The Ball valves are to be in accordance with B.S.1212 : 1970, Part 2, diaphragm type. To be set to give a 150 mm water depth in feed cisterns serving as expansion vessels.

Ball Valves must be of the type NOT subject to DEZINCIFICATION.

M5.7 HOT WATER GENERATOR

A new hot water generator is to be installed in the roof-top plant room above the main stair in Block E. This system is to match the existing system currently installed in the plant room to simplify maintenance and operation matters.

The system is to comprise a hot water generating boiler and an associated buffer vessel.

Hot Water Boiler

The hot water boiler is to be gas-fired to heat hot water directly. The unit is to output 142kW of power to heat water to a minimum of 60°C with an internal water volume of 27 litres, capable of operating up to 8 Bar of static pressure, and is to be capable of raising the entering water temperature by 17°C in a single pass. Flue gas maxima are to be as follows: CO₂ 10.2%; NO_x 35 mg/kWh; CO 14 mg/kWh. The unit is to be complete with a 3/4 inch gas connection and is to utilise a 150mm flue.

The unit is to be no greater than 1105mm from front to back, with a width no greater than 670mm and a height no greater than 1440mm excluding the flue.

The unit is to be a Baxi SF61 unit, as supplied by:

Baxi Commercial Division
Wood Lane
Erdington
Birmingham
B24 9QP

or equal and approved

The boiler is to be arranged in a loop with a buffer vessel (cylinder), utilising a circulating pump between the boiler and the cylinder.

System Pump

The system pump is to be a Grundfos UPS 32-80B, with a flow rate of 7.2 m³/h against an internal resistance of 14kPa, or such other pump as is recommended by the boiler manufacturer to achieve the appropriate flowrate

Hot Water Cylinder

The cylinder is to be mounted vertically with a capacity of 308 litres, fabricated from high-grade carbon steel with an inner glass lining, insulated by a removable aluminium-covered jacket.

The unit is to include a replaceable magnesium anode within the cylinder and a temperature and pressure gauge and a self-sealing wet pocket for a BMS temperature probe.

The cylinder is to be capable of withstanding a maximum pressure of 10 Bar, and a maximum water temperature of 95°C.

Dimensions, complete with insulating jacket are to be 1650mm height x 750mm diameter. Water inlet and outlet connections are to be 1 inch nominal. An inspection opening is to be located towards the bottom of the unit with a minimum diameter of 110mm.

The system is to be supplied complete with 25 litre expansion vessel and a matched temperature and pressure relief valve.

To be type ST300 cylinder with WUV75/24/75 unvented systems kit, expansion vessel and pressure relief valve, and M0011 temperature and pressure gauge and self-sealing wet pocket.

As supplied by:

AO Smith
Unit B8
Armstrong Mall
Southwood Business Park
Farnborough
Hampshire
GU14 0NR

Tel: 08702 676 484

M5.8 COLD WATER BOOSTER SET

Not required

M5.9 OVERFLOW PIPES

Filters

To comply with B.S.6700 and the Water Regulations, the overflow and warning pipe from each cold water storage tank should each be fitted with line size filters as manufactured by:

J. Wagner & Partners
3 Samuel Street
Macclesfield
Cheshire
SK11 6UW

or equal and approved.

Routes

(a) Tank Overflows

The main overflows from tank are to run on the roof and terminate over the nearest drainage channel.

(b) Tank Warning Pipes

The warning pipes are to run to the edge of the roof and are to discharge on to the ground.

WC Cistern Overflows

Most WC cisterns now have internal overflows without requirement for any additional overflow pipework. If the WC cisterns do not have internal overflows then each WC cistern is to be provided with an easily visible recessed tundish arrangement of neat appearance with a glass front cover to comply with the Water Regulations.

Each tundish is to accept the overflow discharge from its respective WC cistern. The outlet of the tundish is to be connected to the WC flush pipe which is to convey overflowing water to the WC pan.

Details of the proposed unit are to be submitted for approval prior to manufacture and installation.

Materials

Overflow pipes over 50 mm size are to be run in galvanised steel to B.S.1387, Heavy grade. Smaller overflow and warning pipes are to be run in copper (Table X); uPVC may be used instead where the pipes are inaccessible to the occupants, and can be securely bracketed.

M5.10 TRACE HEATING

No trace heating is required under this contract: the hot water service is to include a full return loop.

M5.11 HOT WATER BLENDING VALVES AND TAPS

Hot water blending valves are to be installed at various locations as described below:

To all wash-hand basins, except Accessible WC wash-hand basins, where integral single-lever thermostatic blending taps are to be used.

Hot water blending taps are to be installed at accessible WC basins.

Note 1: hot water outlets to the Kitchen and Cleaners' Room sinks are not temperature regulated to enable cleaning at elevated water temperatures. These sinks are to be fitted with a local wall-mounted notice stating "WARNING - HOT WATER" in contrasting colours.

Accessible wash-hand basins

The hot and cold water supply to each wash-hand basin in the Accessible Toilets is to be supplied by a single lever sequential thermostatically-controlled Monobloc pillar tap mounted on the basin.

The tap is to be fabricated in brass, with a chrome finish
To conform to HTM64, HTM04 and Building Regulations, Approved Document M
To comply with the requirements of TMV3
WRAS approved
Single sequential lever providing cold water initially through to a maximum temperature of 41°C.
Suitable for both gravity and pressurised systems
Complete with strainers, check-valves and pressure limiters
With individual hot and cold tails.

To be:

Contour 21 washbasin mixer (TP6), A4169

Supplied by:

Ideal Standard (UK) Ltd,
The Bathroom Works,
National Avenue,
Kingston upon Hull
HU5 4HS

Tel: 01543 490 253

Wash-hand basins (not Accessible)

The hot water supply temperature to each wash-hand basin in each Toilet is to be reduced by means of a mechanical thermostatic valve which blends hot water from the water heater with mains cold water.

Each thermostatic mixing valve is to be as follows:

A thermostatic mixing valve for mixed water distribution in the temperature range 34°C-60°C suitable for operation with a minimum hot and cold differential temperature of 15°C, and with anti-scalding safety mechanisms to shut off hot water supply if no cold flow is detected. (Initial setting to be 38°C, user adjustable)
Equal sized inlet and outlet ports ½ inch nominal
Designed for operation in the range 1-10 bar.
10 year warranty
Fully accessible filters and non-return valves
Capable of 'thermal shock' (anti-legionella) operation by manual adjustment and re-setting.

Valve model to be: Premix Nano 732116

As supplied by:

Delabie UK Ltd
Henderson House
Hithercroft Road
Wallingford
Oxfordshire
OX10 9DG

All valves to have integral non-return valves and Keysafe isolating valves and strainer units on hot and cold inlet connections.

M5.12 CONNECTIONS TO WCs

All connections to WCs are to incorporate solenoid valves on the BCWS connection to isolate the supply when the toilet areas are unoccupied. These are to be controlled via a PIR sensor and shall be a Cistermiser or similar.

M5.13 CONNECTIONS TO SANITARY WARE

All sanitary fittings, lavatory basins, sinks, etc., will be supplied and connected under a separate Contract. The Mechanical Services Contractor must however include for all final connections.

M5.14 CONNECTIONS TO EQUIPMENT

The Mechanical Services Contractor must include for making the final connections to all equipment supplied under the Mechanical Services Contract.

M5.15 PRESSURE TESTING

Prior to the application of any insulation, boxing-in, erection of ceilings, etc., the whole of the mains water, tank water, and hot water services must be hydraulically pressure tested, and witnessed by the Consulting Engineer or his representative, to a pressure of 10 bar gauge.

M5.16 INSULATION

The hot and cold service pipes are to be insulated throughout their length, except where on view in occupied areas. Note: hot and cold water pipework in open-ceiling areas above nominal ceiling height is to be insulated as if in an enclosed space.

For details of insulation refer to the Thermal Insulation Section (M8).

M5.17 STERILIZATION OF PIPED WATER SERVICES

All domestic hot and cold water pipework is to be sterilized before the system is brought into use for domestic purposes. The Mechanical Services Contractor is to ascertain whether the responsible local Water Company has regulations pertaining to the sterilization of water mains. If so, the Contractor is to be responsible for ensuring that the work is carried out in accordance with such regulations and/or local Byelaws.

In the absence of any specific Regulation the water mains shall be sterilized in accordance with B.S.6700. The Contractor is to inform the Consulting Engineers of the method he is proposing to use and to obtain approval in writing prior to carrying out the work.

Precautions are to be taken to ensure that the sterilizing medium does not flow back into any service main supplying the water to the section under sterilization.

The Contractor is to arrange for bacteriological samples to be taken and submitted to the Public Analyst or other competent Authority for examination.

The Contractor is to provide for the attendance of a specialist firm to supply the necessary equipment for, and to superintend the work of, sterilization and is also to provide for attendance in connection with the work and for flushing and draining the mains before and after treatment as required.

Should samples prove unsatisfactory on examination, the sterilizing procedure must be repeated until satisfactory conditions have been achieved.

SECTION M6 - SOIL, WASTE AND CONDENSATE DRAINS

M6.1 GENERAL DESCRIPTION OF THE WORKS

The works to be carried out under this section are to include:

1. The supply and installation of all standard soil and waste services above ground floor slab level as indicated on the drawings and as detailed in this Specification.
2. The supply and installation of condensate drains from fan-coil units, to run in the ceiling voids then into either soil and waste stacks or rainwater downpipes as indicated on the drawings.
3. The supply and installation of drains from air-handling cooling coils, which discharge to local soil and waste stacks.
4. The carrying out of the necessary tests as detailed within this Specification and as directed by the Consulting Engineer and the representative of the Chief Environmental Health Officer of the Local Authority.

The soil and waste service is to be installed in cast iron, copper, and plastic pipework as detailed within this Specification.

The condensate system within the ceiling voids and zones, and plantrooms is all to be in copper tube. Vertical stacks may be in copper or cast-iron at the Contractor's option.

The whole of the works to be complete with all necessary pipework, brackets, supports, etc.

All pipework and general matters are to be in accordance with the Standard Technical Requirements.

The requirements relating to pipework supports are as specified for other pipework in Section M2.

The underground drainage and rainwater systems (including any new connections/pop-ups) are to be provided and installed under a separate sub-contract to the Main Contract.

The Mechanical Services Contractor is to liaise with the Main Contractor to ensure that suitable connections are provided in the positions required, for the Mechanical Services Contractor to make all necessary connections between above-ground drainage and underground drainage, condensate stacks.

M6.2 PAYMENT OF FEES

Where necessary the Mechanical Services Contractor is to give all notices to the Local Authority Environmental Health Officer's Department and pay all fees arising thereunder in connection with testing of the installations.

M6.3 COMPLIANCES WITH REGULATIONS

Every installation is to comply in all respects with and give notices required by: the Current Editions of the British Standard Specifications, the Local Authority Bye-Laws, the Water Regulations, and the Factory Acts Regulations in force at the time of tendering.

The Contractor is to include for all fees payable under this heading and ensure that all fittings etc., are tested and stamped before delivery to the site.

M6.4 LAYOUT OF WORK

The Mechanical Services Contractor is to exercise care and consideration when installing the works and is to plan all pipe runs to fit into their surroundings as neatly and unobtrusively as possible. All pipework is to be positioned so that it does not clash or interfere with other units, equipment, or services.

The exact position of pipe runs, equipment, etc., may require to be adjusted from the positions shown on the Drawings to suit final arrangements of room layouts, architectural features, etc. The Mechanical Services Contractor is to be responsible for checking details with the Main Contractor, and where a pipe run or equipment position appears to be incorrect, he is to immediately notify the Consulting Engineers who will agree details and confirm to the Mechanical Services Contractor in writing.

The workmanship is to be in accordance with the best accepted practice and the installation work is to be carried out in accordance with current Code of Practice B.S.5572:1994.

Any pipe or fitting or item of equipment which the Consulting Engineers considers to be incorrectly installed is to be removed and correctly refixed at the expense of the Mechanical Services Contractor.

M6.5 GENERAL REQUIREMENTS FOR PIPEWORK

Pipes and fittings to be of smooth bore, sound and free from defects.

All joints made in pipework and to appliances should be airtight and watertight, and should remain so during use. Care should be taken to ensure that no jointing material projects inside the bore of the pipe. Some flexibility is desirable where there is a possibility of movement in a pipeline or between the pipe and appliance and provision should be made in the assembly of the pipework to accommodate and control thermal movement.

Where pipes pass through walls or solid floors, they should be accommodated in sleeves of inert material which should extend through the full finished thickness of the floor or wall and be secured against movement. Sleeves to be fireproofed, where installed in a fire compartment wall or floor. Sleeves for any plastic pipes having a nominal internal diameter greater than 40 mm are to be provided with intumescent collars where necessary to comply with Building Regulations.

The Mechanical Services Contractor is to provide the Main Contractor with a dimensioned builderswork drawing showing the locations of all stacks and drainage gulleys at the points where they are to connect into the underground drainage.

M6.6 SOIL, WASTE, VENT PIPES AND STACKS OF CAST IRON

All 100 mm and 70 mm pipework is to be in cast-iron. Pipes and fittings are to be constructed of cast-iron to ISO 6594. Pipes to be grey iron, exceeding the requirements of B.S.1452 Grade 150. Internal coating to pipes to be minimum 120 micron thickness of black epoxy. External coating to be two coats of anti-oxidant alkyde paint, average 70 microns and minimum 40 microns thickness.

Fittings are to be finished in epoxy powder, average 70 microns and minimum 40 microns thickness.

Cast iron pipes and fittings are to be the “Ensign” soil type and are to be installed strictly in accordance with the manufacturer’s instructions. The Mechanical Services Contractor is to give the Consulting Engineers’ representative the opportunity to check a sample number of torqued bolts on a sample number of fittings. If the Consulting Engineers’ representative finds bolts not correctly torqued then the Mechanical Services Contractor must satisfy the representative that the rest of the installation is correctly installed.

Vertical stacks to be fixed at each floor level with two piece floor-cramp size 25 mm x 6 mm galvanised and separated from the cast iron pipe with a ring of mineral fibre tape.

One intermediate bracket to be fixed between floors, similar to the floor-cramp but with 9 mm rod with ring at one end and thread at the other end fitted to Plumbing duct wall with galvanised Red-heads.

The maximum interval between brackets on horizontal pipework is to be 1.8 metres. More frequent bracketing is to be provided where necessary for proper and secure support. Brackets to be designed for the pipe, and not less substantial than 38 mm x 6 mm flat mild steel formed into two semi-circular clips, bolted together around the pipe with M8 bolts.

‘Continuity clips’ are to be incorporated into joints to provide electrical continuity to satisfy the I.E.E. Regulations.

M6.7 SOIL, WASTE AND VENT PIPES OF COPPER

All pipework 54 mm (and below) nominal bore, all condensate pipework and also any other pipework specifically stated or shown on the Drawings as being copper, is to be installed in copper pipework and fittings.

All visible waste and overflow pipework serving each Disabled W.C. and all visible pipe connections to basins and urinals in toilets generally, are to be installed utilising chrome-plated copper tube and fittings.

Copper piping to be in accordance with B.S.2871, Part 1, Table X, to suit the fitting.

Copper fittings on waste pipes to be ‘Conex’ Waste Pipe Fittings as manufactured and supplied by I.B.P. Ltd., Whitehall Road, Tipton, West Midlands. All fittings in plumbing ducts and voids, to be self colour finish. All fittings to have joints made by Econa split taper ring to permit easy disconnection, as required for cleaning and maintenance.

Copper connections to bosses on cast iron pipes to be made with Econa stack type insulated connector.

Copper tubes are to be securely fixed with either copper saddle clips, screwed to the wall with copper or brass schoolboard clips or two piece clips built into or fixed to walls or ceilings.

The maximum allowable interval between brackets is to be 1.5 metre on vertical pipes, and 1.1 metre on horizontal pipes. These fixings are a maximum and it is the Mechanical Services Contractor's responsibility to ensure that all pipes are properly and securely fixed.

Drain pipework from fan-coil units and air-handling unit items to be installed in light grade copper tube to B.S.2871, Part 1, Table X. All fittings to be compression type, permitting easy disconnection for cleaning and maintenance.

Trapped connections are to be formed from an assembly of compression fittings, except where bottle traps are called for in this Specification or on the Drawings. Traps on cooling coils in air-handling units are to be transparent.

All fittings for copper pipework to be manufactured by:

Yorkshire I.M.I Ltd.

or equal and approved.

All fittings must be of the type NOT subject to dezincification.

M6.8 PVC PIPEWORK

Pipework other than that described in Clauses M6.6 and M6.7 is to be installed in MuPVC pipe and fittings, (for soil and waste systems).

MuPVC pipework to be in accordance with B.S.5255 and fittings in accordance with B.S.5255 or 4514.

Pipework and fittings to be as manufactured by:

Caradon Terrain Ltd.,

their Type Terrain 200 system

or equal and approved.

All pipework and fittings to have seal ring connection joints with female iron branch connectors for connection of copper branch pipework.

The maximum allowable interval for fixing brackets is to be 1.0 metres and it is the Sub-Contractor's responsibility to ensure that all pipes are properly and securely fixed.

General requirements for MuPVC pipework are in other respects as for copper pipework.

Appropriate fire protection in the form of collars, etc, is to be installed on any PVC pipework passing through a fire compartment barrier.

M6.9 OVERFLOW PIPES

Overflow pipes and warning pipes are all generally as described in Section M5 of this Specification.

M6.10 FLOOR GULLEYS

Floor gulleys are to be Ensign adjustable floor drains comprising:

1. Square nickel bronze inspection cover with stainless steel vandal-proof screws.

Note: Due to connection to SVP from a soil/waste stack, gulley to be sealed type with removable cover for draining purposes.

2. Adjustable grating housing in nickel bronze.
3. Cast iron clamping ring with stainless steel securing bolts and waterproof membrane.

4. Outlet body with necessary clamping rings.
5. Outlet tail pipe.
6. 'P' type trap.

Constructed of cast iron to ISO 6594 and EN877. All fittings are to be coated with either a tar basis coating or natural bitumen to prevent corrosion.

M6.11 WC CONNECTORS

The WC Connections are to be supplied and fitted within this Contract. All to be of the 'Multikwik' type, sized to suit the WC spigot, and installed in accordance with the manufacturer's recommendations.

As manufactured and supplied by:

Phetco (England) Ltd.
26a High Street
Totton
Southampton

M6.12 TRAPS

(i) Sanitary Ware

All traps to the sanitary fittings within this Specification are to be supplied and fitted within the Contract. All traps to have 75 mm seal. Wash-hand basin traps (unless otherwise noted) and (only where noted) other traps are to be of the anti-syphon type.

All traps to wash-hand basins and urinals in the Male, Female, and Disabled Toilets are to be chromium plated bottle traps. The traps serving the Cleaners' sinks is to be metal tubular type.

(ii) AHU Cooling Coils

Attention is drawn to the dimensional and material requirements regarding traps on cooling coils, as set out in Clause M4.2 of this Specification.

Traps directly connected to cooling coils are to be constructed from transparent material to enable any build-up of sediment to debris to be monitored and easily removed.

(iii) Fan-Coil Condensate

Condensate lines in ceiling voids which connect; directly into building drainage may incorporate a HepVo self-sealing trap as manufactured by:

Hepworth Plumbing
Hazlehead
Crown Edge
Sheffield
S36 4HG

or equal and approved.

M6.13 PROTECTION DURING BUILDING CONSTRUCTION

Every care should be taken to protect the work and to prevent the entry of foreign matter into any part of the system during construction. Openings should, therefore, be kept sealed with purpose made fittings.

Special care should be taken with pipe systems having ring seal joints to prevent deflection of the joint after the pipework is assembled. Pipework should not be allowed to carry any external load either during or after construction.

All access covers and cleaning eyes should be fitted at the time of installation and be finally fixed and sealed after testing.

M6.14 GRADIENTS

The gradient of branch discharge pipes must be uniform and adequate to drain the pipe efficiently. Pipe sizes, gradients, and pipe capacities are all inter-related but generally minimum gradients of 20 mm/m should be achieved. Particular care must be given to discharge pipes from wash hand basins, to ensure that they comply with the recommendations in the British Standard.

Condensate drains in ceiling voids are to be run with a minimum fall of 10 mm per metre.

Any locations which appear to require shallower falls are to be discussed with the Consulting Engineer in good time before the pipework is installed.

M6.15 ACCESS FOR MAINTENANCE

Access covers and cleaning eyes are to be positioned wherever necessary to allow cleaning and maintenance equipment to be easily inserted into the pipework and to permit cleaning or clearing all parts of the systems. Any access covers or cleaning eyes shown on the drawings are also to be incorporated as required.

All soil, waste, and vent stacks are to have access doors, as B.S.416:1973, 500 mm above Basement slab level to enable the rodding of drains.

Condensate stacks to have a removable screwed plug, within each ceiling void, for cleaning purposes.

All cleaning access points on copper wastes to be of the screwed type, comprising an Econa blank cap with rubber washer.

All cleaning access plugs at ends of cast iron pipes and 100 mm copper pipes to comprise a cast iron Ferrule with brass Screw Cap caulked into a soil pipe socket as B.S.22.

All wire balloons at termination of ventilating pipes to be of copper to dimensions given in Table 22 B.S.416:1973.

M6.16 TESTING

On completion of all works, the installation is to be tested by the Mechanical Services Contractor. Tests are to be carried out in accordance with the procedure detailed in Section 10, Items 10.1 to 10.3.3.3 inclusive of B.S.5572:1994 Code of Practice for Sanitary Pipework. The Mechanical Services Contractor is to provide a written Certificate of the installation having been fully and satisfactorily tested.

The Mechanical Services Contractor is also to carry out any testing required by the Local Authority's representative.

M6.17 SANITARY WARE

All sanitary ware is to be supplied and fixed by others. The Mechanical Services Contractor must only include for connecting the Soil and Waste, and Overflows from the following:

- WC Soil Connections - Pans are to be salt glazed suitable for the WC connector specified in Clause M6.11.
- WC and Cisterns - Each cistern is to be installed complete with Overflow with a 22 mm tank connector. The Mechanical Services Contractor must extend the overflow from the cistern commencing with a female iron x copper connector.

Alternatively the cistern may have an internal overflow in which case an approved strainer will be required as described in Section M5.
- Wash-Hand Basins - The basins are to be installed complete with a 32 mm chrome waste. The Mechanical Services Contractor must include for a chromium-plated bottle trap and extending the copper waste pipework from the trap to the waste stack, chromium-plated where visible.
- Cleaners' Sinks - The sinks are to be installed complete with a 40 mm chrome waste. The Mechanical Services Contractor must include for a tubular trap and extending the copper waste from the trap to the soil stack.
- Shower Trays - Shower trays and 'wet room' type shower installations are to have top access waste connections with resealing trap assembly and 40 mm waste connection to drain point.

SECTION M7 - GAS SERVICES

M7.1 GENERAL DESCRIPTION

The works to be undertaken under this section include:

1. The modification of existing roof-top gas pipework to accommodate a new hot water heating boiler.
2. Removal of gas unit-heaters in Block D, along with local pipework. (Service to other unit-heaters in the same block to be retained.)
3. Testing and commissioning.

The whole of the works to be complete with all necessary pipework, brackets, fittings, valves, etc., all as specified and/or indicated on the Contract Drawings.

The 80mm diameter gas service on the roof of Block E is to be extended into the roof plantroom. Within the plantroom, the service is to be branched to serve both the existing and the new gas-fired water heating boilers.

The gas service to the roof plantroom is to be modified to include a line-sized solenoid fire valve as described in Section M9 of this specification.

The gas service in Block D is to be modified to include the removal of unit heaters in way of new class rooms in the area. This is to include the careful removal of unnecessary pipework, blanking of removed pipework and re-commissioning of retained heaters after completion of the removal works.

All work is to be strictly in accordance with British Gas recommendations and safety requirements, and is to be tested, commissioned and put to work.

The gas installation must comply with the recommendations of the Institution of Gas Engineers' "Utilisation Procedures I.G.E./UP/2, Communication 1598 - Gas Installation Pipework, Boosters, and Compressors on Industrial and Commercial Premises".

All gas pipework downstream of the incoming service metering equipment is to be of fully welded construction using medium weight tube to B.S.1387 and in accordance with Section M2 of this Specification.

M7.2 ISOLATING VALVES

Isolating valves on pipelines up to and including 50 mm Nominal Bore are to be gas threaded, DZR, lever operated ball valves as Hattersley Fig. 100 YL.

Isolating valves on pipelines 65 mm Nominal Bore and above are to be lever operated, fully lugged, wafer pattern butterfly valves as Hattersley Fig. 971

SECTION M8 - THERMAL INSULATION

M8.1 GENERAL DESCRIPTION OF WORKS

The Mechanical Services Contract is to include the provision and fitting of thermal insulation of the type, grade and thickness all as specified later but generally:

1. To all pipework (except gases, drains, overflows and warning pipes) on the roof.
2. To all refrigerant pipework, whether concealed from view or exposed.
3. To all domestic mains water, tank cold water, and hot water service pipework except where exposed to public view below ceiling level in occupied areas.
4. To the water storage tanks, if they are not pre-insulated.
5. To the hot water storage heaters, if they not pre-insulated.
6. To all fan-coil unit discharge ductwork, including bendable ductwork, and any galvanised steel plenums which are not insulated by the manufacturer.
7. To all supply ventilation ductwork in ceiling voids, in risers, and where otherwise hidden from view.
8. To all supply and extract ventilation outside of the building, including at roof-top level. This is also to include complete aluminium cladding along the entire length.
9. To all fresh air intake and supply ductwork.
10. To all attenuators in insulated ductwork.
11. To extract ductwork which is to convey air that is either to be re-circulated or used for heat recovery, i.e. up to Run-Around coils.

Insulation is to be installed in a neat manner, and particular attention to neatness is required in the plantroom and other areas where it is exposed to view. The method of installation of each type of insulation is to be strictly in accordance with the manufacturer's recommendations.

All insulation is to be in accordance with B.S.5422:2009 and the appropriate thickness tables therein. The thermal conductivities of the insulating materials and tables to be used are as listed below: (Tables based on B.S.5422:2009 are included in Clause M8.12.)

All insulation is to be zero ODP and a maximum GWP of 5 such as phenolic foam as manufactured by Kingspan Kooltherm, installed fully in accordance with their requirements and recommendations. A complete vapour seal shall be made to all insulated ductwork, even at support points.

A Class 0 foil finish is to be applied throughout, with matching 100mm wide self-adhesive Class 0 tape.

(a) Heating Pipework:

Use B.S.5422:2009, Tables 15 & 16, for a hot face temperature of 75°C, based on thermal conductivity of 0.040 W/(m·K) for Mineral Wool and 0.025 W/(m·K) for Phenolic Foam.

(b) Hot Water Service Pipework:

Use B.S.5422:2009, Table 17 & 18, for a hot face temperature of 60°C based on a thermal conductivity of 0.040 W/(m·K) for Mineral Wool and 0.025 W/(m·K) for Phenolic Foam.

(c) Cold Water Pipework within Plantrooms:

Use B.S.5422:2009, Table 29 (Indoor Installations), based on a thermal conductivity of 0.035 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

(d) Cold Water Pipework elsewhere within the Buildings:

Use Table 8, for contents at 10°C based on a thermal conductivity of 0.040 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

(e) Chilled Water Pipework and Run-Around Pipework:

Internal Pipework:

Use Table 8, for contents at 5°C and a thermal conductivity of 0.040 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

External Pipework:

Use Table 29, and a thermal conductivity of 0.035 W/(m·K) for Mineral Wool and 0.020 W/(m·K) for Phenolic Foam.

Or use the same thickness as for heating pipework in (a) above (Table 12) whichever is the greater thickness.

(f) Trace Heating

Where pipework has trace heating tape along its length, due allowance is to be made for "pipe insulation" size to accommodate same. The thickness of insulation should also be as recommended by the trace heating tape manufacturer if thicker than B.S.5422:2009. This applies to HWS pipework for maintaining the "hot" temperature or any other pipework for freeze protection.

All flanges and valves on insulated pipework of 65 mm nominal bore and larger are to be fully insulated. Valves flanges and all other fittings on chilled and cold water pipework are to be fully insulated and vapour sealed.

All flanges, valves, and other fittings which are to be insulated on any pipework are to be enclosed additionally in removable buckle-fixed 0.6 mm Stucco Aluzink (Dobelshield) enclosures.

All services in the plantroom which are less than 2.5 metres above floor level to their underside, are to be fully insulated and finished with 0.6 mm Stucco Aluzink (Dobelshield) sheet metal.

Ductwork in plantrooms and on roof areas is to be clad with 0.7 mm Stucco Aluzink (Dobelshield) over the specific insulation.

All insulation is to have a factory applied finish of "Bright Class 0" reinforced aluminium foil. The Mechanical Services Contractor is to be responsible for ensuring that no paint or other covering is applied to the surface of any portion of the insulation that will impair its Class 0 rating.

Any insulation work which is at variance with the specified requirements, or which exhibits inferior workmanship, is to be removed and subsequently replaced free of charge.

All pipes and ducts are to be insulated individually, and not in groups of two or more, and there is to be a minimum of 25 mm clearance between finished surfaces, and 25 mm finished clearance from any building surfaces unless otherwise specified. The Mechanical Services Contractor is to ensure that all pipes and ducts are installed so as to meet this requirement. Any variation from this requirement must have the approval of the Consulting Engineers prior to the installation of the pipework or ductwork.

Care is to be taken that no insulation or cladding by-passes or interferes with-any vibration isolation provisions.

The Mechanical Services Contractor will be responsible for the protection of all equipment during the application of insulation and is to promptly remove all waste, surplus material, and packaging from the site. All un-insulated plant and equipment is to be thoroughly cleaned and left clear of fouling by insulating materials.

No thermal insulation work is to be put in hand until after the satisfactory completion of leakage testing, as specified elsewhere.

The Mechanical Services Contractor is to state on the Summary of Tender the name of the firm or firms to whom the insulation work will be sub-contracted. The firm selected must be of good repute, and a member of the Thermal Insulation Contractors Association.

M8.2 HEATING. HOT AND COLD WATER SERVICES

Heating pipework, hot water services pipework, and all types of cold water service pipework are to be insulated in the following manner.

(a) In Ceiling Voids, Ducts and Voids

To be insulated with rigid preformed sections of "Kingspan Kooltherm Phenolic Foam" or "Knauf Crown Glassfibre" or "Rockwool Rockfibre", each having a factory applied reinforced aluminium foil facing material, or equal and approved. Finish to be Class 'O' as specified by the Building Regulations, Approved Document B, to the satisfaction of the Local Authority's Building Control Officer. Sections are to be close-butt, and all longitudinal and circumferential joints are to have an overlap of facing material of not less than 50 mm. Overlaps and butt joints to be well sealed with an adhesive or self-adhesive foil tape approved by the insulation manufacturer and conforming to the Class 'O' requirements. Sections are to be taped into mitred lengths to run in uniform thickness around all bends, sets, and tees.

(b) Final connections to Fan-Coil Units

All 15 mm and 22 mm copper pipework forming the final connections to the fan-coil units is to be insulated with Armaflex closed-cell elastomeric insulation with a Class 'O' finish, with thermal conductivity not exceeding 0.041 W/m·K at 20°C, 19 mm thickness. The insulation is to be un-split and continuous and with no butt joints between the mains and the units except as necessary for valves.

Alternatively, should the Armaflex section be split, the insulation must be glued using a non-flammable grade of adhesive, and the joint is also to be continuously sealed by a Class 'O' adhesive tape, all as recommended by the manufacturer. The ends of the insulation are to be neatly finished at a minimum distance from the fan-coil unit.

If final connections utilise flexible couplings, then they are to be of the pre-insulated type.

(c) In the Plantrooms

High level horizontal pipework, above 2.5 m AFL, is to be insulated as for (a) above.

Other pipework to be as specified in (a) but finished with 0.6 mm Stucco Aluzink (Dobelshield) sheet metal fixed with pop rivets. The sheeting is to be installed with the seam along the hidden side of the pipe wherever possible.

On cold water services, (and on chilled water), a sacrificial layer is to be applied below the Aluzink cladding to prevent the rivets from penetrating the vapour barrier on the insulation.

(d) Exposed to Weather

Any pipework exposed to the weather is to be insulated and weatherproofed as for external chilled water.

It should be noted that the mains cold water and boosted cold water service running at Basement level is to be electrically trace heated as specified elsewhere and the insulation sections, support brackets, etc., are to allow sufficient space for this.

M8.3 CHILLED WATER SERVICES

Chilled water pipework is to be insulated in the following manner:

(a) External Chilled Water Pipework

External pipework and fittings are to be insulated as for L.P.H.W. in ceiling voids, but with the following further requirements.

The insulation is to be finished with a covering of Idenden 20-28 General Purpose Mastic, a heavy duty weatherproof finish applied in two coats. The first coat is applied and wrapped with No.10 glass cloth which is embedded into the first coat to act as a reinforcing material. The second coat is applied in accordance with the manufacturer's procedures.

or, (at the Contractor's option):

All pipework up to 100 mm to be protected with a final finish of 0.6 mm Stucco embossed Aluzink (Dobelshield).

All joints, seams and penetrations to be sealed with silicone flexible mastic to ensure a weatherproof and vapour-proof finish.

Cladding to be secured by self-seal pop rivets.

It should be noted that the chilled water flow and return pipework external to the Plantroom is to be electrically trace heated as specified elsewhere, and the insulation sections, support brackets, etc. are to allow sufficient space for this. Sections are to be close-buttred, and all longitudinal and circumferential joints are to be sealed by having overlap of facing materials of not less than 50 mm sealed with an adhesive. Alternatively all butt joints sealed with Idenden T303 aluminium foil adhesive tape as approved by the Insulation manufacturer to form a complete vapour barrier and weathering seal.

Sections are to be formed into mitred lengths to run in uniform thickness around all bends, sets, and tees.

At all pipe support brackets (Kooltherm or similar), high density pipe insulation support units, of a thickness equal to the pipe insulation thickness, are to be installed, with the pipe clips installed over the weatherproof finish. Insulation sections are to be close-buttred to these units, sealed with Idenden flexible joint compound and the weatherproof finish taken over the joints, with the completed work giving a reliable vapour-proof finish.

Flanged joints are to be insulated with oversized insulation sections and site-cut rigid slab sections with the weatherproof finish neatly dressed over the complete assembly, all sealed in accordance with the manufacturer's recommendations. All external valves, including metering stations, are to be insulated with 50 mm flexible mineral mat (Ductwrap) covered in Bright Class '0' faced foil with all joints taped to maintain the vapour seal around the valve and the adjacent pipework. The valves to have a removable 0.6 mm Stucco Aluzink (Dobelshield) box which is to have an internal insulated lining with vapour seal, to avoid damage to the valve insulation when the box is removed and re-fitted.

The Mechanical Services Contractor is to ensure that even minor items (e.g. pipes to sensors, etc.), are fully insulated to prevent freezing and, where main pipes are trace heated, the minor items are also to be trace heated.

It should be noted that during the course of commissioning, access will be required to double regulating valves, metering stations and test points, and due allowance should be made for removal, replacement, temporary weathering and making good of insulation as necessary .

(b) Chilled Water Pipework within Service Risers and Ceiling Voids

To be insulated as for LPHW pipework in ceiling voids, but with the following additional requirements.

The complete aluminium foil covering is to form an efficient vapour barrier.

At pipe support brackets (Kooltherm or similar), high density pipe insulation support units, of a thickness equal to the pipe insulation thickness, are to be provided with pipe clips installed over the vapour barrier and sealed to the pipe insulation vapour barrier to ensure a continuous vapour seal.

All sizes of flanges and valves are to be fully insulated complete with vapour barrier.

It should be noted that access to double regulating valves and metering stations is required. The Mechanical Services Contractor is to allow for removal, replacement, and making good as necessary during commissioning.

(c) Chilled Water in Plantrooms

To be insulated as described in (b) above, with an additional cover of 0.6 mm Stucco Aluzink (Dobelshield) finish sheet metal, where required by Clause M8.2(c), with sacrificial layer.

Valves are additionally to have a removable 0.6 mm Stucco Aluzink (Dobelshield) - cover, as in (a) above.

(d) Chilled Water Branch Pipework in Ceiling Voids to Fan-Coil Units

All copper pipework forming the final connections to individual fan-coil units or pairs of fan-coil units is to be insulated as specified for the L.P.H.W. final connections, but with all valves also insulated.

For the chilled water, attention is to be given to forming a continuous vapour barrier. Chilled water valves and fittings are to be insulated with oversize sections, cut and shaped as detailed in the manufacturer's installation manual. It is to be noted that access to the double regulating valves and metering stations is required for commissioning purposes and the insulation covering is to be readily removable and secured with quick-release tabs.

M8.4 PIPEWORK GENERALLY

Where water pipes pass through walls and floors, the Mechanical Services Contractor is to supply and install an insulated sleeve in each hole which:

- (a) Provides fire separation between the rooms to the Local Authority's satisfaction.
- (b) Does not diminish the acoustic attenuation of the wall or floor.
- (c) Provides insulation which complies with B.S.5422:2009, for the appropriate table.
- (d) In the case of cold or chilled water, maintains the vapour barrier on the outer surface of the insulation, resisting any abrasion during insertion of the sleeve.

Suitable sleeves which achieve all of these objectives are to be provided and any gap between sleeve and hole must be packed and sealed, to avoid any reduction in the fire-resistance or sound attenuation.

On pipes requiring a vapour barrier, particular attention is to be given to vapour sealing the insulation on both sides of each sleeve. The sleeve is to be extended clear of the surface of the wall/floor, and the vapour barrier is to overlap it, and be bonded to it. Where the insulation has to be broken or terminated, the vapour barrier is to be dressed back to the surface of the pipe or fitting; any unavoidable penetrations are to be sealed in accordance with the insulation manufacturer's recommendations.

Copper Pipework

Before applying any type of insulating material over copper pipework, the following procedure should be carried out in order to reduce the risk of pinhole corrosion which can be caused by surplus flux and other corrosive elements sometimes present in water and in the dust from building site materials:

- (i) Completely wipe clean the surface of the copper pipe to remove all traces of surplus flux, moisture, building material debris and dust.
- (ii) Proceed to fit the insulating material in the normal manner.

M8.5 DUCTWORK

All ductwork insulation is to be supplied and installed under this Contract.

Ductwork to be insulated is as stated in the Description of Work in Clause M8.1.

The material to be used is phenolic foam, fibreglass or Rockwool duct insulation, faced with Bright Class "0" reinforced aluminium foil, conforming to Class '0' of the Building Regulations, Approved Document B, to the satisfaction of the Local Authority's Building Control Officer.

Insulation thickness is to be in accordance with B.S.5422:2009 Tables 12 or 13 as indicated in Clause M8.12. The aluminium foil finish is to provide a vapour seal. Insulation to be firmly secured with adhesive recommended by the insulation manufacturers. All joints are to be carefully sealed with Idenden T303 (or similar) adhesive tape, as recommended by the insulation manufacturers. The finished result is to comply with the Class '0' requirements just specified.

Rectangular duct insulation is to be rigid slabs, cut to fit on site so that the top and bottom pieces overlap the sides. Insulation beneath the duct is to be additionally supported as recommended by the manufacturers. Insulation density to be not less than 40 kg/m³ giving a thermal conductivity of 0.040 W/m·K for mineral fibre and 0.020 W/m·K for phenolic foam at 10°C mean temperature.

Circular and flat oval rigid and bendable ducts are to receive compression resistant flexible insulation. Insulation density to be not less than 24 kg/m³, giving a thermal conductivity of 0.038 W/m·K at 10°C mean temperature. Galvanised wire mesh is to be applied overall, to all flexible insulation, around the full circumference, for additional support and reinforcement of the insulation. Bendable ducts may be insulated by the duct manufacturers, in which case the wire mesh may be omitted.

Wherever possible, ducts are to be installed so as to enable the insulation to be applied without being permanently compressed. Any exceptions to this requirement must have the prior approval of the Consulting Engineers.

It may be necessary for thinner insulation to be used on ducts wherever they pass through or close under beams, pipes or other obstructions. The thinner insulation is not to extend more than 100 mm either side of the obstruction. The surface is to be made good to the surface of the adjacent thicker insulation, so as to maintain the vapour seal throughout. Great care is to be taken to avoid damage to insulation where ducts pass through or under beams.

All joints are to be close-buttet.

Ductwork in Plantrooms

Ductwork in plantrooms to be fully insulated and finished 0.7 mm Stucco embossed Aluzink (Dobelshield) with the exception of flexible connections to AHUs/Fans.

M8.6 INSULATED DUCTWORK BRACKETS

The Mechanical Services Contractor is to draw his Ductwork Sub-Contractor's particular attention to high density phenolic foam (or similar) load bearing types of support for insulated ductwork with a vapour barrier. The method required is indicated in Section M2 of this Specification. Any insulator supporting the duct must comply with the Class 0 requirements of the Building Regulations.

M8.7 COLD WATER STORAGE TANKS

Cold water storage and header tanks are, where possible, to be pre-insulated. Where this is not possible, insulation to be in the form of phenolic foam laminate sheets finished with reinforced aluminium foil. Where flanges on sectional tanks are deeper than 50 mm, the insulation thickness is to be at least equal to the flange depth, so that the outside surface finish/vapour barrier runs straight across the flanges. All joints are to be taped with matching adhesive tape to form a continuous vapour barrier. Supporting pins are to have a secure adhesive, suitable for the tank material. Thermal conductivity not to exceed 0.032 W/m·K at 10°C mean temperature. All to comply fully with the Supply (Water Fittings) Regulations 1999.

Where buffer vessels are on view in plantrooms, the insulation is to be clad in 0.7 mm Stucco Aluzink (Dobelshield). Any pressure sensors, etc., to be fully accessible.

M8.8 HOT WATER VESSELS

Hot water vessels, where possible, to be pre-insulated. Where this is not possible, insulation to be in the form of 50 mm thick rigid fibre glass or Rockwool, secured with 'chicken' wire mesh or 25mm slotted phenolic foam laminate secured with aluminium bands. Insulation to have a reinforced aluminium covering bonded on. All joints to be close-butted and finished with suitable matching adhesive tape.

Site insulated vessels on view in plantrooms are to have their insulation clad in 0.7 mm Stucco Aluzink (Dobelshield). Insulation and cladding to be arranged to allow the primary battery and access ports to be removed without disturbing the remainder of the vessels' insulation.

M8.9 PAINTING OF PIPEWORK BEFORE APPLICATION OF INSULATION

As stated in the Section G3.

M8.10 IDENTIFICATION

All pipes are to be identified in strict accordance with B.S.1710, with colours to B.S.4800, and are to be further marked with the direction of flow. Such identification is to be applied at intervals not exceeding 15 metres, and more frequently as necessary for clarity where any confusion might otherwise exist.

M8.11 BANNED MATERIALS

Particular attention is drawn to the list of banned materials set out in the Main Contract.

M8.12 INSULATION THICKNESS TABLES

Based on B.S.5422 : 2009 Table 8 - Thickness of insulation for chilled and cold water supplies to prevent condensation on a low emissivity outer surface (0.05) with ambient air conditions of 25°C and 80% rh.

Steel pipe size (mm)		Temperature of water (°C)					
		+10		+5		0	
NB	OD	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
15	21.3	11	20	15	28	19	36
20	26.9	12	22	17	30	21	38
25	33.7	13	24	18	32	22	41
32	42.4	14	25	19	35	24	44
40	48.3	14	26	20	36	25	46
50	60.3	15	28	21	39	27	49
65	76.1	16	30	22	42	28	53
80	88.9	17	31	23	44	30	55
100	114.3	18	34	25	47	32	60
125	139.7	19	36	26	50	34	63
150	168.3	20	38	28	52	36	67
200	219.1	21	40	30	56	38	72
250	273	22	43	31	60	40	77
300	323.9	23	45	33	63	42	80
350	355.6	24	46	34	64	43	82
400	406.4	25	47	35	67	45	86
450	457	25	49	36	69	46	88
500	508	26	50	37	71	47	91
600	610	27	52	38	74	49	95

NOTE: Thicknesses given are calculated specifically against the criteria noted in the Table. These thicknesses may not satisfy other design requirements. In situations where the ambient air temperature is greater than 20°C and/or the relative humidity exceeds 80%, these thicknesses will not be sufficient to control condensation.

Based on B.S.5422 : 2009 Table 12 - Thickness of insulation for condensation control on ductwork carrying chilled air in ambient conditions indoor still air temperature +25°C, relative humidity 80% for insulation dewpoint temperature 21.3°C external surface emissivity = 0.05

Minimum air temperature inside duct	Minimum thickness of insulating material	
(°C)	(mm)	
	Phenolic Foam	Mineral Wool
15	15	29
10	26	52
5	37	75
0	48	95

NOTES:

1. Thicknesses given are calculated in accordance with BS EN ISO 12241:1997 based on 0,6 m vertical flat surface of rectangular duct but are also adequate for horizontal surfaces.
2. Thicknesses given are calculated specifically against the criteria noted in the Table. These thicknesses may not satisfy other design requirements,
3. Refer to Annex B, Table B.1 for surface emissivities of common finishing materials. In situations where the ambient air temperature is greater than 25°C and/or the relative humidity exceeds 80%, these thicknesses will not be sufficient to control condensation.

Based on B.S.5422 : 2009 Table 13 - Indicative thickness of insulation (mm) for ductwork carrying warm air to control heat loss.

Thickness conductivity at insulation mean temperature	
Phenolic Foam	Mineral Wool
17	33

NOTES:

1. Heat loss relates to the specified thickness and temperature.
2. Insulation thicknesses in this Table have been calculated according to BS EN ISO 1224:1998 using standardised assumptions; horizontal duct at 35°C with 600 mm vertical sidewall in still air at 15°C, emissivity of outer surface of insulated system as specified.

Based on B.S.5422 : 2001 Table 29 - Minimum insulation thickness required to give protection against freezing - Selected commercial and institutional conditions.

		Insulation thickness			
		(mm)			
		Specified Conditions 1		Specified Conditions 2	
Outside diameter (mm)	Inside diameter (bore) (mm)	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
Copper Pipes					
15.0	13.6	23	78	68	413
22.0	20.2	10	23	21	58
28.0	26.2	7	13	13	28
35.0	32.6	5	10	9	18
42.0	39.6	4	7	7	13
54.0	51.6	3	5	5	9
76.1	73.2	2	4	4	6
108.0	105.0	2	3	3	4
Steel Pipes					
21.3	16.0	18	48	44	173
26.9	21.6	10	21	20	52
33.7	27.2	7	14	13	29
42.4	35.9	5	9	9	17
48.3	41.8	4	7	7	13
60.3	53.0	3	6	5	10
76.1	68.8	3	4	4	7
88.9	80.8	2	4	3	6

Specified Conditions 1 Water temperature 2°C; ambient temperature -6°C; evaluation period 12 hours; permitted ice formation 50%; indoor.

Specified Conditions 2 Water temperature 2°C; ambient temperature -10°C; evaluation period 12 hours; permitted ice formation 50%; outdoor

NOTES:

1. Thicknesses given are calculated specifically against the criteria noted in the Table. These thicknesses may not satisfy other design requirements.
2. Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing. To provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled water circulation of the water and/or trace heating.

Based on **B.S.5422 : 2009** Table 15 - Environmental thickness of insulation for non-domestic heating installations to control heat loss.
(Low emissivity outer surfaces $\epsilon = 0.05$)

Steel pipe size (mm)		Hot face temperature of installation (°C)					
		LTHW (+75)		MTHW (+100)		MTHW (+125)	
NB	OD	Thickness of insulation (mm)					
		Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Mineral Wood	Calcium Silicate
15	21	15	30		30	30	80
20	27	20	35		40	40	
25	34	20	35		45	50	
32	42	20	35		50	70	
40	48	25	40		50	70	
50	60	25	40		60	80	
65	76	25	45		60	80	
80	89	25	45		70	80	
100	114	30	50		70	90	
150	168	30	50		70	100	
200	219	30	50		80	100	
250	273	35	50		80	100	

Based on **B.S.5422 : 2009** Table 16 - Environmental thickness of insulation for non-domestic heating installations to control heat loss.
(High emissivity outer surfaces $\epsilon = 0.9$)

Steel pipe size (mm)		Hot face temperature of installation (°C)					
		LTHW (+75)		MTHW (+100)		MTHW (+125)	
NB	OD	Thickness of insulation (mm)					
		Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Mineral Wood	Calcium Silicate
15	21	20	30		35	35	80
20	27	20	35		45	45	
25	34	20	35		50	60	
32	42	25	35		60	70	
40	48	25	45		60	80	
50	60	25	45		70	80	
65	76	30	50		70	80	
80	89	30	50		70	80	
100	114	30	60		80	100	
150	168	35	60		80	100	
200	219	35	60		80	120	
250	273	35	60		90	120	

Based on **B.S.5422 : 2009** Table 17 - Environmental thickness of insulation for non-domestic hot water services to control heat loss
(Low emissivity outer surfaces $\epsilon = 0.05$)

Steel pipe size (mm)		Water temperature of 60°C	
		Thickness of insulation (mm)	
NB	OD	Phenolic Foam	Mineral Wool
15	21	15	25
20	27	15	30
32	34	20	30
40	48	20	35
50	60	20	35
65	76	25	35
80	89	25	35
100	114	25	40
150	168	25	40
200	219	30	40
250	273	30	45

Based on **B.S.5422 : 2009** Table 18 - Environmental thickness of insulation for non-domestic hot water services to control heat loss
(High emissivity outer surfaces $\epsilon = 0.9$)

Steel pipe size (mm)		Water temperature of 60°C	
		Thickness of insulation (mm)	
NB	OD	Phenolic Foam	Mineral Wool
15	21	20	30
20	27	20	35
32	34	20	35
40	48	25	40
50	60	25	35
65	76	25	45
80	89	25	45
100	114	30	45
150	168	30	50
200	219	30	50
250	273	30	50

NOTES:

Thicknesses given are calculated specifically against the criteria noted in the table. These thicknesses may not satisfy other design requirements. The thicknesses shown in brackets are nearest the standard thicknesses available from manufacturers.

Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing. To provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by thermostat controlled water circulation of the water and/or trace heating.

Specification Clause M8.1(e) advises same thickness as for heating pipework (Table 12) whichever is the greater thickness

SECTION M9 - AUTOMATIC CONTROLS

M9.1 GENERAL DESCRIPTION

The automatic controls for all mechanical services are to be supplied, installed, commissioned and demonstrated under this contract. The control systems are to be generally electronic/electric.

All control valves, actuators, linkages, sensors, controllers, relays, etc., necessary for fully operational systems are to be provided under the Contract, unless specifically otherwise stated. All controls are to be selected by the Controls Sub-Contractor to ensure stable and accurate operation.

The Mechanical Services Contractor is to arrange for the Controls Sub-Contractor's schematic and wiring drawings to be forwarded in duplicate to the Consulting Engineers for comment in reasonable time before manufacture or installation proceeds. Irrespective of any comments, it is the responsibility of the Controls Sub-Contractor, through the Mechanical Services Contractor, to ensure that the finished installation performs as specified in this Section.

The control panels are to be supplied and installed under this contract. Wiring of motors, equipment, sensors, valves, dampers, etc., from the outgoing terminals of the control panel is to be carried out by the Controls Sub-Contractor. The Mechanical Services Contractor is to ensure that the outgoing terminals are sized to suit the cables concerned.

External wiring diagrams for the control panels, detailing terminal numbering, cable sizes and number of cores, are all to be provided by the Controls Sub-Contractor under this Contract in good time to allow the work to be carried out.

The reference codes adopted in the Schedules at the end of this Section are to be followed throughout the project, indicated on all drawings, and included on engraved Traffolyte labels permanently fitted to the relevant item at the completion of the project by the Controls Sub-Contractor.

Items marked 'Future' will not be installed initially. However, the control panels and B.M.S. system are to be supplied as if they are to be initially installed. When the 'Future' equipment is installed, it is to be a simple operation of connecting it up and commissioning the systems.

The field-mounted devices marked 'Future' are not to be supplied initially.

The Mechanical Services Contractor is to check with the manufacturers of all mechanical plant and equipment that the motor and the electrical equipment sizes stated in this Specification are correct, and is to inform the Consulting Engineers in the event of an alteration. The Mechanical Services Contractor is also to ensure that the details of the controls and wiring of all plant and equipment are made available to the Controls Sub-Contractor. The Controls Sub-Contractor is responsible for ensuring that his control systems are fully compatible with the requirements of all plant and equipment.

The Mechanical Services Contractor is to prepare drawings confirming the exact locations of all items to be wired, before electrical installation work is started.

The control panels must be delivered to site to suit the Contract programme. Panel design and wiring diagrams must proceed in sufficient time to allow any comments necessary to be made and incorporated prior to manufacture of the panel.

The control panels to be of sheet steel, painted with primer, undercoat, and topcoat of oil-based paint to an approved colour. They are to have front access hinged doors for maintenance. All lamps, gauges, manual controls, etc., are to be arranged in a logical array on the front face of the panels, at a convenient height, with 'Traffolyte' labels to indicate their function. To be arranged for top entry of all cables unless otherwise stated. Externally-mounted control panels must be weatherproof, and constructed from GRP.

Unless otherwise stated, all controls, starters, etc., for plant are to be located in the control panels. Refer to Control Panel Schedule for the number and location of each panel.

The Automatic Controls components covered by this Section are to incorporate the products of the following manufacturer:

Trend

The selected manufacturer's products must be used throughout, except where inappropriate or where otherwise specified later.

The programmable controllers are to be manufactured by Trend.

The Controls Sub-Contractor is to be:

Building Technology Systems Ltd.,
241 Europa Boulevard
Gemini Business Park
Warrington
WA5 5TN

or equal and approved.

M9.2 STANDARD REQUIREMENTS

The control panels are to incorporate the standard requirements of this Clause, unless specifically otherwise stated.

- (a) Starters are to be provided for the motors of all equipment associated with each control panel.

Each DOL starter is to be contactor-type, complete with suitably rated HRC fuses of the "Motor Starting" type, and thermal overloads with protection against single-phasing. The coils of all starters are to be rated for 24 Volts A.C. and all operating and interlock circuits are to be at this voltage. Overloads are to be set to suit the motor. A Red "Trip" lamp and a Green "Run" lamp are to be provided for each starter. Auxiliary contacts are to be provided as necessary. Manual control switches are to be as specified in the appropriate clause. All Run and Trip statuses are to be monitored by the B.M.S. Alarms are to be signalled for trip and read-back occurrences.

Each Star-Delta starter is to be of the multi-contactor type, with suitable interlocks between the contactors, and a suitable automatic timer to control the closing of the Delta contactor. Each Star-Delta starter is to start the associated motor in "Star", however the start is initiated. Each Star-Delta starter is to be de-energised whenever the isolator local to the motor is opened. An auxiliary pole is to be provided on the isolator of each Star-Delta motor for this purpose. In other respects, the starter is to be equipped as for DOL starters specified above.

Where auto-changeover is specified, each motor is to have its own starter or VFD and associated lamps, switches, fuses, etc., all as specified above. An additional "No. 1/No. 2/Duty Sharing" lead motor selector switch is to be fitted. In the event of the selected motor tripping, the 'trip' lamp for that motor is to illuminate, and control is to be transferred to the other motor.

The run and trip status of each starter/contactors/VFD is to be monitored by the B.M.S.

With ELV control circuits, it may be necessary to have a low current control relay within the remote control circuit to prevent voltage drop affecting the main starter operation. It is the Control Sub-Contractor's responsibility to determine and supply this relay if it is required.

Where a manual switch with 'Duty Sharing' is specified, the 'lead' motor of a pair of duty/standby motors is to be alternated automatically each time the plant is run, when the switch is at "Duty Sharing". If the motor is required to run continuously, then the Duty/Standby motor is to be alternated automatically every 7-days at a time suitable to the operation of the plant.

Where variable speed control of motors is required, they are to be provided with Variable Frequency Drives (VFD) as follows:

Each motor is to be controlled by a dedicated VFD which is also to provide motor protection for overcurrent and loss of phase along with the normal facilities provided by the manufacturer as standard. The VFD is to have the facility to control the motor speed in response to a 0 to 10V signal from the B.M.S. Run and Trip lamps are to be provided on the panel fascia and the operating status is to be monitored by the B.M.S. An "ON/OFF/AUTO" selector switch is to be provided for each motor on the control panel fascia. When at "AUTO", the motor is to be started and stopped by the B.M.S. Each VFD is to be provided with a T.P.& N. contactor-controlled power supply from the control panel.

The motor speed is to be monitored by the B.M.S.

When at "ON", the motor is to run at a speed which is to be manually adjustable at the VFD's keypad.

The VFDs are to be as manufactured by Danfoss Ltd., and are to be provided by the Controls Sub-Contractor. They are to be suitable for either panel or field mounting as specified later.

(b) Fire Precautions

The control panel which controls fans and any boiler plant is to be wired to an interfacing relay on the fire alarm system, to override to OFF the operation of all supply and extract fans, and where applicable to close the gas safety valve in the event of a fire alarm.

All supply and extract fans are to be wired to provide overriding control by Fireman's switches. All Fireman's switches are to be located in a composite Fireman's Control Panel. Each switch is to be capable of overriding all other automatic or manual controls so as to switch the associated fan(s) on or off at the option of the fireman. The details of the Fireman's Control Panel and the functions of its switches are given in the appropriate clauses. Connection between the Fireman's Control Panel and Plant Control Panels are to be hard-wired, as described in a later clause. The required functions are to be achieved by hard-wired relays within the Plant Control Panels.

The switches are to be easily accessible through a break-glass front panel, which is to be in a hinged frame, with a key-operated latch, to enable the switches to be used for test purposes without breaking the glass.

The panel is to be suitable for flush mounting finished in Red with a label engraved "FIREMAN'S OVERRIDE" in prominent letters.

The Fireman's switches are not to override any Emergency Stop Button, but are to take precedence over the Fire Alarm overrides, which in turn take precedence over the Smoke Detection overrides.

The status of all fire overrides are to be monitored at each MCP and a B.M.S. alarm triggered if any one is in a condition other than normal.

The fire alarm and Fireman's overrides are to be hardwired.

(c) Sequenced Starting

Where the instantaneous starting currents of all motors, etc., connected to a control panel would exceed the capacity of the fuses provided on the electrical supply to the control panels, delay timers are to be provided to reduce the maximum instantaneous current as necessary, when started under automatic control, or by the Fireman's switches.

Sequential starting is to be provided also to ensure that the plant starts in an orderly and safe manner and the correct conditions are met before starting plant.

(d) Thermal Controls

Unless otherwise later specified in any particular instance, every control circuit which automatically controls temperature, humidity, etc., in any air or water system, (other than 2-position control loops), is to incorporate a proportional- plus-integral- plus-differential modulating controller mounted in the control panel of the plantroom concerned. Setpoints are all to be fully adjustable. Proportional band, integral action rate and differential rate are to be adjusted to optimum settings to match the characteristics of the plant concerned. If the Controls Sub-Contractor considers that superior control will be achieved by an integral action controller, then this may be offered as an alternative; it should have fully adjustable setpoint and integral action rate.

Where individual controllers are used for the various control functions, they are to be flush-mounted onto the face of the control panels. Where a composite programmable controller is used, a keyboard and back-lit display for monitoring and adjusting the operation of the systems that are controlled are to be permanently mounted on the front of each control panel.

All thermostats, sensors, actuators, control valves, etc., are to be individually labelled with 'Traffolyte' labels using the reference numbers contained within this Specification.

All settings of all controls are to be fully adjustable.

(e) Electrical Work

Every control panel is to have an isolator on each incoming feeder.

Relays, delay timers, H.R.C. control circuit fuses, etc., are to be provided to ensure fully functional systems.

All internal wiring is to be neatly loomed, with numbered ferrules at both ends of every wire, corresponding to the numbering on the Controls Sub-Contractor's wiring diagram.

All external connections are to be via numbered "Klippon" clamp type terminal blocks, or equal.

Any wiring and equipment which could remain live when panel doors are open is to be shrouded and provided with warning labels. All internal starters, relays, timers, etc., are to be identified with "Traffolyte" labels. All work is to comply with the latest Edition of the I.E.E. Regulations.

Equipment and wiring within Control Panels is to be segregated into two categories:

1. Control circuits operating at voltages at which the I.E.E. Regulations permit bodily contact. Wherever possible, control equipment is to be in this category.
2. Control circuits necessarily operating at higher voltages. 400/230 Volt power distribution circuits. Starters and Contactors.

Category 1 is to be accessible without shutting down the Control Panel, and without risk of contact with equipment operating at high voltages.

Category 2 is to be protected by a door-interlocked isolator and/or is to have fully shrouded terminals, fuseholders, etc., so that there is no risk of electric shock by inadvertent contact for an electrician working within the control panel. Relays are to be of the plug-in replaceable type.

All Control Panels are to have control circuits operating at 24 Volt 50 Hz. Where this is not possible, then all control circuits greater than 50 Volts must be on the same phase, to prevent interconnections from giving rise to a presence of 415 Volts at, say, a Fireman's Control Panel.

Control circuit transformers are to be manufactured to B.S.3535/EN 60742.

Control circuits within the panel are to be sub-fused to ensure operating integrity of sections of plant and restrict a single fault shutting down large amounts of Plant.
e.g.

Circuit 1: Boilers, Primary Pumps, Gas Valve and Control Devices

Circuit 2: Variable Temperature Secondary Pumps and Mixing Valve

Circuit 3: Chilled Water Pumps and Control Devices

Circuit 4: Air-Handling Plant

Discrimination is required between the sub-circuit fuses and control circuit transformer protection fuses.

Where a Form 4 Panel is supplied each compartment will have its control circuit separately fused and both poles isolated by the door interlocked isolator.

The circuits of any contacts which signal to other panels or equipment, and which are energised from outside the control panel, or any other items which are energised from outside the control panel, are to be either:

- (i) Appropriately shrouded, and fitted with warning notices, or
- (ii) Located in the Category 2 area, and isolated by auxiliary poles on the main control panel isolator, or
- (iii) If the voltage is sufficiently low, located in the Category 1 area.

Indication lamps are to be flush-mounted on the panel fascia, be a minimum of 22 mm diameter and have a multi-segment LED lamp of sufficient intensity to be easily visible under normal ambient light conditions. The lamps are to be replaceable from the panel fascia without the need to shut the panel down. All lamps are to operate at 24 Volt maximum.

(f) Time Switches

Any time switches, unless otherwise specified, are to have a 7-day dial, sub-divided into hours, or the electronic equivalent. They are to have a 36-hour battery reserve which is self recharging. To have two 'ON' and 'OFF' settings for each day.

(g) Emergency Stop Facilities

Each control panel is to be provided with an integral twist-to-reset Red emergency stop button, clearly identified. The button is to drop out a relay in the control panel, which is to stop all plant controlled from that control panel, and where the outgoing power supply is derived from the control panel to disconnect all supplies greater than 50 Volts. Attention is drawn to the requirements of the I.E.E. Regulations and the European Machines Directive in respect of wiring of emergency stop circuits.

Additional remote emergency stop button(s) are to be provided within any Plantroom adjacent to each entry and are to be wired to any control panels controlling equipment/plant in the relevant Plantroom, to provide the same functions as the stop button described above.

(h) Frost Trip

Where 'Frost Trip' is specified, an automatic-reset duct thermostat with averaging element is to be provided downstream of the coil(s) needing protection from frost; the setpoint of the thermostat is to be adjustable in the range from 0°C to 10°C.

The thermostat is to be of the type the operation of which is NOT affected by changes in the ambient air temperature around the head of the instrument.

If the air temperature at the thermostat remains below the setpoint for longer than 30 seconds (adjustable), the Frost Trip relay for the AHU concerned is to operate. This relay is to:

- (i) Shut down the fan(s) in the AHU and any associated extract fan(s).
- (ii) Open fully any control valves on coils in the AHU.
- (iii) Close fully the automatic dampers on the air inlet into the AHU supply and exhaust fans and, where applicable, motor dampers to the full recirculation position.
- (iv) Illuminate a "Frost Trip" warning lamp for the AHU, on the Control Panel.

Each Frost Trip relay is to have an associated "Re-set" button, which resets the relay to its normal state. The lamp is thereupon to revert to normal. After resetting the Frost Trip, the delay of 30 seconds is to be re-initiated, so that the trip relay cannot again be operated until this delay time has expired.

(i) Dirty Filter Warning

All filters in air-handling units, and wherever else also specified later, are to have associated 'Dirty Filter' warning systems. In each case the system is to comprise:

- A differential pressure switch connected across the filter and set to the 'dirty' pressure drop (determined by the AHU manufacturer or as later specified).
- An associated lamp on the Control Panel, (labelled 'Filter Dirty' and identifying the filter concerned), which lights whenever the pressure drop exceeds the setting of the d.p. switch.

(j) Alarms and Warnings

Alarms and Warnings are to be relayed to the B.M.S. supervisor.

'Alarms' are for occurrences which require immediate attention, namely:

Frost trips

Motor or Equipment trips, where there is no standby, or where the standby is also tripped.

Any dangerously low or high room or pipe temperatures.

Any other items specified later.

'Warnings' are for less urgent occurrences, namely:

Motor or Equipment trips, where there is an operational standby

Dirty filters

Any other items specified later.

The status of all alarms and warnings are to be recorded on the P.C's hard disc.

Alarms are also to be auto-dialled via the modem, to the remote monitoring station.

(k) Spare Ways

Each Control Panel is to have two spare T.P.& N. outgoing ways, fitted with 32 Amp H.R.C. fuse-holders and Neutral Links.

(l) Valve Exercise

Where a B.M.S. system is specified, the outstation strategies are to be programmed to automatically exercise all control valves once per week to prevent sticking.

Each control valve is to be driven fully open and fully closed twice during the exercise.

The valve exercise routine is not to initiate any other automatic functions related to the valve position.

The routine is not to be carried out on plant that is running under normal automatic control.

The routine is to be carried out at a time when the minimum amount of plant is running.

(m) Pipe Line Equipment

All pipe line equipment associated with the water services in the building is to have a normal pressure rating no less than 10.0 bar.g.

M9.3 BUILDING MANAGEMENT SYSTEM (B.M.S.)

The College mechanical systems are currently controlled by a Trend BMS. This system was installed by Building Technology Systems Ltd., of Warrington. The BMS is to be retained and is to be essentially unamended except where specifically stated.

All new system controls are to be achieved by modification of the BMS or, in the case of the new VRF systems, by installation of manufacturer's control equipment that is interfaced with the BMS for the provision of time signals and fault signals. Where possible, changes are to be undertaken within the existing panels: where the contractor considers that a new panel is required, this is to be identified to the Engineer at an early stage of the contract.

Documentation, in the form of Logic Block printouts, outstations and supervisor back-up disks are to be included for all modified and added outstations and supervisors in the Controls Sub-Contractor's manuals.

Back-up disks are to be provided in the manuals for all outstation strategy software.

The computer, ancillaries, and software along with the schematic generation and commissioning are to have the cost separately identified from the overall control package.

M9.4 VRF HEATING AND COOLING SYSTEM

New heating and cooling is to be added to many areas of the scheme. In these areas, VRF refrigerant-based heating and cooling cassette units are to be utilised. This system is to comprise a roof-mounted (or other external plant space-mounted) 'outdoor' unit, connected by refrigerant pipework to an indoor branch controller (BC box), which is in turn connected by refrigerant pipework to each of the local heating and cooling fan-coil cassette units mounted at high level or on walls, as indicated on the contract drawings.

Each fan-coil unit is to include a local return-air temperature sensor for reference and control, and a local wall-mounted control unit.

This system is to operate under the dictates of its own proprietary (Mitsubishi) control system to see that, during hours of operation, rooms are maintained at the appropriate temperatures in the most energy-efficient mode. Frost protection for the areas covered by the VRF system is to be maintained by the Mitsubishi system. This control system is to be installed and set to work by the Mitsubishi Installer.

The Mitsubishi controller is to be linked to the BMS via the nearest existing Control Panel to receive run and stop signals in accordance with operating time zones. The Mitsubishi system is to report maintenance warnings and critical alarms back to the BMS.

M9.5 LOCAL ELECTRIC HEATERS

A number of local electric heaters are to be installed throughout the building to serve small rooms such as one-on-one meeting rooms.

These heaters are all to be supplied complete with integral time-clocks and thermostats and are to operate independently from the Building Management System.

M9.6 FRESH AIR AND EXTRACT SYSTEM

General fresh air to the College is provided via actuator-controlled openable windows, see Clause M9.7 for details.

Most areas incorporate central mechanical extract ventilation systems, and some include both supply and extract ventilation systems. While changes are to be made to the distribution and/or collection ductwork for these systems, in general no control changes are to be made. However commissioning checks and re-balancing will be required under this contract. The BMS Sub-Contractor is also to confirm that, following alterations to these systems, all are left functioning as originally specified.

A new supply and extract air-handling unit, AHU 1001, is to be installed in the roof plant area above Block F (the former Theatre area). This unit is to supply and extract air for the Animal Welfare teaching areas located on the Ground Floor of this Block. The unit is to comprise:

(a) Supply Air Section:

- Intake isolating damper, for which a 2-position actuator and linkage is to be provided.
- Electric frost coil, for which Thyristor control is to be provided.
- Panel filter bank, for which a differential pressure switch is to be provided.
- Bag filter bank, for which a differential pressure switch is to be provided.
- Thermal Wheel energy recuperator.
- Supply fan (driven by a variable speed motor).
- Two-stage reverse-cycle heating and cooling DX coil (connected a Mitsubishi PUZ-ZM100YKA.UK condensers, controlled by PAC-IF013B-E master and PAC-SIF013B-E slave units)

(b) Extract Section:

- Panel filter bank, for which a differential pressure switch is to be provided.
- Thermal Wheel
- Extract fan (driven by a variable speed motor).
- Exhaust isolating damper for which a 2-position actuator and linkage is to be provided.

Duct temperature sensors are to be provided: in the supply air discharge from the AHU, downstream of the frost coil (averaging element), downstream of the recuperator in the supply AHU, and downstream of the recuperator in the extract AHU.

A duct frost thermostat as standard requirements with extended element is to be provided after the frost coil.

A duct temperature sensor and duct relative humidity sensor are to be provided in the exhaust air duct, upstream of the extract fan.

A smoke sensor is to be provided in the supply air discharge from the AHU and in the return air duct upstream of the extract filter. These sensors are to be connected to the Fire Alarm System.

Fans

The supply and extract fans serving the same wing are to have a common "HAND/OFF/AUTO" switch, but separate Green "Run" and Red "Trip" lamps. When at "AUTO" they are to operate according to the daily programme and "Day Extension" timers.

They are to be provided with VFDs as Standard Requirements, Clause M9.2.

The motorised dampers are to open whenever the supply and extract fans are required to run.

The fans are to be overridden as follows (in descending order of priority):

- To 'OFF' by either of the Emergency Stop buttons
- To 'ON' or 'OFF' by the (existing) Fireman's override switches.
- To 'OFF' by the Frost Trip

An Alarm is to be signalled if either fan is tripped, or if the Frost Trip operates, or any of the fire overrides are operated.

Temperature Control

The frost coil is to be Thyristor controlled. The Thyristor is to switch 'on' when the outdoor temperature is less than or equal to 0°C (Zero) and to 'off' when the outdoor temperature is greater than or equal to 5°C (adjustable).

Step control within the band of 0°C to 5°C is to be linear between the 'on' and 'off' positions.

The supply air temperature is to be controlled at setpoint by demand to the master Mitsubishi PAC-IF013B AHU controller in steps, with the PAC units able to coordinate 11 steps between the two condensers from 1 (20%=minimum) to 11 (100%=maximum) in either heating or cooling mode.

The setpoint of the supply air temperature is to be 21°C (adjustable) if the outside air temperature is below 16°C (adjustable) during boost periods.

During occupancy hours and during "Day Extension" operation:

- (a) The setpoint is to be 21°C (adjustable) when the outside temperature is above 21°C (adjustable)
- (b) A 'dead-band' is to operate when the outside air temperature is in the range 16°C-21°C (adjustable).
- (c) The setpoint is to be 16°C (adjustable), when the outside temperature is below 16°C (adjustable).

Frost Trip

As standard (see Clause M9.2).

Dirty Filter Warning

As standard, (see Clause M9.2).

M9.7 AUTOMATIC OPENABLE WINDOWS

Automatic openable windows (and, in some areas, associated automatic opening roof-vents) are installed all-round the College. These openable windows form an essential part of the existing and of the new building ventilation strategy.

Original automatic opening windows are marked on the contract drawings as 'AWxxx' (where xxx is a number between 001-999). New opening windows are marked 'AWxxxx' (where xxxx is a number between 1001-1999).

Existing

The controls sub-contractor is to undertake a full survey of the existing window actuators to confirm both correct mechanical operation and correct control operation in accordance with the original ventilation strategy. This is to include the roof-mounted actuator-controlled vents that form part of the same strategy (for Block E, Ground Floor), but which are not shown on the contract drawings.

M9.8 NEW EXTRACT FAN SYSTEMS

A single new extract system is to be installed in the Ground Floor Teaching Kitchen area of Block F. This is to be a locally controlled unit with a wall-mounted controller.

M9.9 HOT AND COLD WATER SERVICE

The existing hot and cold water services for the College are to be retained and maintained as they are, with a number of additional or modified hot and cold branches taken from these systems.

For the new Health and Beauty department on the Third Floor of Block E, a considerable number of new water outlets are required. To this end, a new water heater and buffer vessel arrangement is to be installed in the roof-top hot water plant room. The operation of this system is to be the same as for the current unit located in the plantroom.

The water heater unit is to be gas-fired. The existing gas supply to the plant room is to be up-sized to suit, requiring a new line-sized solenoid gas shut-off valve to be installed under this contract.

M9.10 FROST PROTECTION

The existing frost protection regime of the BMS is to be extended to the newly installed and controlled items.

M9.11 DAY EXTENSION, ETC.

The 'day extension' regimes of the existing BMS are to be extended to the new plant added to the BMS under this contract.

M9.12 DAILY PROGRAMME

The 'daily programme' on/off timing regimes of the existing BMS are to be extended to the new plant added to the BMS under this contract.

M9.13 WEATHERPROOFING

All equipment located external to the building is to be either inherently waterproof, or provided with a robust purpose-made removable weatherproof cover.

M9.14 FAULT WARNING

All newly installed equipment added to the BMS is to include a fault warning: this is to be added to the existing fault warning regime of the BMS.

M9.15 FIREMAN'S OVERRIDE

The existing Fireman's control regimes are to be extended to the new elements installed under this contract. In particular relevant fireman's controls must be maintained over the ventilation and heating and cooling systems.

M9.16 ENERGY CONSUMPTION MONITORING

Meters are to be provided as part of the Electrical Contractor's work (unless specified otherwise) in various electrical circuits.

The B.M.S. is to monitor them via a signal from each meter. This will be in the form of a MODBUS data connection.

The Controls Sub-Contractor is to provide any interfaces necessary and software to enable the B.M.S. to monitor the energy used at each meter.

The Controls Sub-Contractor is to propose a strategy for monitoring and recording all available energy inputs.

M9.17 COMMISSIONING

All automatic controls are to be commissioned as stated in Section M2 of this Specification. Before offering the systems for witnessing and acceptance, the Mechanical Services Contractor is to satisfy himself that they are all in full working order, and is to have fully tabulated records of the settings of all controllers, etc., and of the resultant plant performances, in terms of temperatures, flowrates, pressure drops, etc., as appropriate to the controls concerned, and in sufficient detail to establish that the control systems comply with the specified requirements.

The Mechanical Services Contractor is to note that close liaison with the Controls Commissioning Engineer and the Air-Conditioning Commissioning Engineers is required and that co-ordination of the various parties is his responsibility.

Any systems which are found to be at variance with the Specification are to be re-adjusted and corrected before being offered again for acceptance. The Consulting Engineers reserve the right to charge the Mechanical Services Contractor at their normal hourly rates for time abortively spent in witnessing systems that prove to be unacceptable.

M9.18 TUNING, TRAINING AND MONITORING

During the period from Practical Completion of the Contract or until 12 months from completion of the demonstration of the control system, the Controls Sub-Contractor is to monitor all aspects of the B.M.S. remotely via the ADSL link, and is also to include for visiting site to resolve any problems that cannot be resolved remotely. During this period, the setpoints, schedules, programmes, etc., are all to be optimised by iterative methods to achieve the best possible conditions in all areas consistent with energy economy.

Records are to be kept of all adjustments made, including the date, the before-and-after values of the item adjusted, and the reason for the adjustment. Monthly summary reports are to be submitted. During this period, the Controls Sub-Contractor is to train a designated member of the Client's staff in the use of all aspects of the B.M.S. system.

Also during this period, the Controls Sub-Contractor is to monitor all warnings and alarms signalled by the B.M.S., record them, and immediately alert a person designated by the Client. This service is required during normal working hours; overnight or weekend occurrences are to be reported to the Client's designated person at the beginning of the next working day. The Controls Sub-Contractor is to monitor the systems and to make any adjustments to the operating parameters required throughout a whole seasonal change.

M9.19 SUNDRY ITEMS

Local controls (such as thermostatic valves on radiators), are specified elsewhere.

SECTION M10 - AS-BUILT INFORMATION

M10.1 GENERAL

The original mechanical engineering for Blocks D, E and F was undertaken by James Mercer and their sub-contractors under a two separate contracts.

Various as-built drawings and Operation and Maintenance Manuals are available from these previous contracts on site. Some (but not all) of the information is available electronically in PDF format. This information is included with the tender information pack for reference purposes. The veracity of the O&M information has not been verified, and so details should be checked on site before the Contractor relies on them.

The James Mercer contract numbers were/are 4212

M10.2 REFERENCE TO AS-BUILT INFORMATION

Specific reference is made within this Mechanical Specification and on the associated contract drawings to various details contained within the O&M Information. In particular:

Ventilation Schematics for Blocks E & F are shown on James Mercer drawings: 4212/5002 and 4212/5009.

Gas Services and Unit Heaters for Block D are shown on James Mercer drawings: 4212/5507 and 4212/5507.

Underfloor heating services for Blocks E & F are shown on Responsible Energy Management drawings U2978M1 and U2978M2 (REM were sub-contractors to James Mercer).

The Contractor is advised not to restrict their viewing to these drawings alone, but is to review the package to understand better the entire installation.

SECTION M11 - ROOF-TOP PLANT SUPPORT

M11.1 GENERAL

With the specific exception of water tanks, all mechanical and electrical plant and equipment installed at roof level, including control panels, switchboards and similar enclosures is to be mounted on a 'big-foot' frame system.

All pipework, ductwork and electrical tray is to be fully supported by a big-foot support system

M11.2 GENERAL ARRANGEMENT OF PLANT SUPPORT SYSTEM

The support system is to comprise a full steel frame running under each item of plant or, where practical, group of items, in turn supported by adjustable legs mounted on rubber feet to spread the load evenly.

Each frame and foot system is to be designed to support the specific configuration of plant to be held. Frame members are to be arranged to suit particular dimensions of sub-units of plant, such as air-handling units, which are of modular construction to see that no strain is placed on joints, etc.

Where practicable, groups of items such as condensers may be mounted on a common frame for improved stability.

M11.3 PIPE, DUCT AND CABLE SUPPORT

All pipework, ductwork and cable tray (including basket and trunking) mounted on the roof is to be fixed to a support system comprising rubber feet with integral aluminium channel system suitable for direct fixing of tray, pipe-clips, etc.

Depending on size, ductwork may require support by similar frames and feet to those used for plant support.

Supports are to be positioned at no greater centres than would otherwise be required for the particular duct, pipe or tray system; or at closer centres if so required by the supplier.

M11.4 CALCULATIONS AND DESIGN DRAWINGS

The Specialist Sub-Contractor is to provide full calculations and drawings for their selected systems to support the plant and equipment.

M11.5 SUPPLIER

Systems are to be designed, supplied and installed by:

Big Foot Systems Ltd.,
Apex Way
Hailsham
East Sussex
BN27 3WA

Tel. 01323 844 355

SECTION M12 - CONTRACTOR DESIGN

M12.1 GENERAL

Under this contract, the Mechanical Contractor is required to undertake a number of investigations and to detail certain elements of the works themselves. The particular items are noted in the relevant sections of the Mechanical Specification, but are repeated below for clarity. Note: for detailed requirements in each case, refer to the relevant specification sections.

M12.2 INVESTIGATIONS

Underfloor Heating

The Contractor is required to examine the various underfloor heating manifolds on the Ground Floor of Blocks E and F to determine which individual circuits are to be deleted in accordance with the contract drawings. Detail is given in Section M3 of the Mechanical Specification

Mechanical Ventilation Systems

The Contractor is required to undertake full commissioning checks and duct balancing checks for various air-handling units and their associated systems. These checks are to be undertaken at an early stage of the contract to allow time for any remedial actions to be instructed. Detail is given in Section M4 of the Mechanical Specification.

Window Actuators

The Contractor is to undertake a full mechanical and electronic examination of the window actuator and control system and is to refurbish or repair any faults found. Detail is given in Section M4 of the Mechanical Specification.

Building Management System

The Contractor is to undertake an operational check of the existing Building Management System to see that it is operating in accordance with the original specification. Any non-compliances are to be reported in time for any remedial actions to be instructed. See Section M9 of the Mechanical Specification.

M12.3 CONTRACTOR DESIGN

Refrigerant Pipework Design and Routing

The Contractor is to undertake the design of refrigerant pipework sizing and routing, including supports, etc., for the VRF heating and cooling systems. See Section M3 of the Mechanical Specification.

BMS Control of new elements

The programming of control routines for newly installed plant and equipment linked to the BMS, including modified and additional window actuator systems is to be designed by the BMS Sub-Contractor. See Section M9 of the Mechanical Specification.

Plant Support Systems

External plant is to be supported utilising a Bigfoot system. The system is to be contractor-designed. See Section M10 of the Mechanical Specification.