

**NEUADD DYFI HALL
Aberdyfi**

**Provision
of
Hall Ventilation**

Prepared by:-

**Adrian Tester
Building Services Engineer
6 High Street
Aberystwyth
SY23 1JG**

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Neuadd Dyfi Hall
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Details of Tender Price

I/We hereby give details of the breakdown of the engineering cost:

£ p

Preliminaries

Mechanical works

Supply and installation of AHU

Supply and installation of supply ductwork

Supply and installation of extract ductwork

Supply and installation of LPHW circuit serving AHU

Insulation and cladding of LPHW pipework

Insulation and cladding of supply and extract ductwork

Electrical works

Modifications to lighting and trunking

Provision of main and local control panels

Provision of low voltage cabling to sensors, control valves etc

Provision of mains voltage cabling to AHU etc

Builder's work

Forming base for AHU

Modifying the timber floor

Forming penetrations and making good around pipes, ducts, cables etc

Forming supply and extract diffuser and grille openings, making good

Remaining builder's work items

Testing & Commissioning

Commissioning and testing of the ventilation system,
LPHW installation, controls etc

Record drawings, operating and maintenance manuals, provision
of information in accordance with CDM Regulation
and instruction of client's staff.

Any Other Items

Contingency Sum £1,500 - 00

Total Sum (carried forward to Form of Tender) £

Signed.....

Date

In the capacity of

Neuadd Dyfi Hall
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Alternative Price

The Tenderer is invited to state below the details of any changes, which would occur in his Tender Price given on page 3 by the substitution of the following:-

£

Signed..... Date

In the capacity of

.....

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Daywork

Provisional Sums shall be included in the Tender Price for Works carried out on Daywork under the direction of the Engineer. The Tenderer is required to state against each item the Total Percentage in respect of overheads and profit he wishes to add to Labour provided and materials supplied.

These Total Percentages will be deemed to include all possible additions to basic rates, and no further increase at a later date on any grounds whatsoever will be accepted by the Engineer.

Labour

The Total Percentage for Labour shall be added to the “net amount of wages” paid to workmen and chargehands, and shall provide for all statutory and other charges including:

National Health and Unemployment contributions.
National Insurances and Pension Subscriptions.
Normal Contract Works, Third party and Employers Liability Insurances.
Annual and Public Holidays with Pay.
Private Health Plan subscriptions.
Non-contributory Sick Pay Scheme.
Industrial Training Levy.
Redundancy Payment Contributions.
Contracts of Employment Act.
Site Supervision and Staff.
Small Tools etc.
Protective Clothing.
Head Office Charges and Profit.
Bonus or Incentive Payments.
Daily and Periodic Travel Allowances.
Subsistence of Lodging Allowances.
Payments in respect of time lost due to inclement weather.
Safety and Welfare Facilities.

The “net amount of wages” shall mean the amount of wages at the standard time rates applicable when dayworks are carried out, and such extra payments of differentials as are fixed in respect of skill, responsibility, discomfort, inconvenience and risk paid in accordance with the rules and awards of the recognised wage-fixing bodies of the trades concerned, in force in the area in which the work is carried out.

Materials

The Total Percentage of Materials shall be added to the net cost of materials delivered to Site as defined, and shall include the cost of internal haulage on Site and for all other charges, overheads and profit.

Labour	Materials	Plant
%	%	%

Signature.....

Name and Address

of Tenderer.....

.....

.....

Date.....

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List of Proposed Sub-Contractors

The Tenderer must state below these portions of the Works which he intends to sub contract

Works or Trade

Name and Address of Sub-Contractors

Signed.....

On behalf of.....

Date.....

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Appendix

Tenders to be Returned by	:	To be confirmed
Commencement Date (Clause 2.2)	:	To be agreed
Completion Date (Clause 2.2)	:	To be agreed
Liquidated Damages (Clause 2.8)	:	£100 per week
Defects liability period (Clause 2.10)	:	12 months
Injury or Damage to Property (Clause 5.2)	:	£1 million
Insurance of Works (Clause 5.4B)	:	

NB: Clause numbers quoted are from the JCT Minor Works Conditions of Contract.

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Notice to Tenderers

Finance (No 2) Act 1975

Income Tax (Sub-Contractors in the Construction Industry)

Regulations 1975 S.I. 1975/1960.

- 1 The Employer is not a “Contractor” under the above Act. It has, however, been agreed that the Employer should observe the Spirit of the Act.
- 2 Before the Tender is accepted the Tenderer will be required to provide the Employer with the evidence that the Contractor is entitled to be paid without statutory deduction.
- 3 The Employer keeps a record of all payments to Contractors in similar form to that required under the Act for the information of the Inland Revenue.
- 4 Tenderers are reminded the Contractors are required to check the Tax Certification or certifying documents of Sub-Contractors they employ (including any named Sub-Contractors) and to deduct tax as necessary and to comply in all respect with the Act.

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Certification of Non-Collusion

The essence of selective tendering is that the Client shall receive bona fide competitive Tenders from all firms tendering. In recognition of this principle:-

I/We certify that this is a bona fide Tender, intended to be competitive, and that I/We have not fixed or adjusted the amount of the Tender by or under or in accordance with an agreement or arrangement with any other person.

I/We also certify that I/We have not and will not do any of the following acts at any time before the hour and date specified for the return of this Tender.

- a) Communicate to a person other than the person calling for those Tenders the amount or approximate amount of the proposed Tender except where the disclosure, in confidence of the approximate amount of the Tender was necessary to obtain insurance premium quotations required for the preparation of the Tender.
- b) Enter into any agreement or arrangement with any other person than he shall refrain from Tendering, or as to the amount of any other Tender to be submitted.
- c) Offer or pay or give or agree 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 or anybody or association, corporate or un-corporate, and “any agreement, or arrangement” includes any such transaction, formal or informal and whether legally binding or not.

Signed.....

on behalf of.....

Date.....

Section 1

Contract Preliminaries

1.1 Nature of Contract

The scope of the Works is as described in this Specification and on the accompanying Drawings. The installation shall comply with all Statutory Legislation also Local Authority and Statutory Undertaker Bye-laws together with IEE Wiring Regulations (17th Edition), Gas Safety Regulations, Water Bye-laws, Health & Safety Regulations etc. This contract includes for the supply, delivery, unloading, storage, installation, testing, commissioning and subsequent maintenance of all the materials necessary for the works as shown on the drawings and described in this specification.

1.2 Conditions of Contract

The Works described in this specification and the contract drawings are to form the subject of a Contract to be carried out on the terms and conditions as defined in the Joint Contracts Tribunal's *Agreement for Minor Building Works*, 2011 version with latest amendments.

1.3 Supervisor

The Contractor shall inform the Engineer before the start of the works, the name of the responsible person attending daily on the site who will be undertaking the duties of Contract Supervisor and Safety Supervisor.

1.4 Specification & Drawings

This Specification is to be read in conjunction with the drawings together with relevant documents from the Joint Contracts Tribunal's Agreement for Minor Building Works form of contract.

The Contractor shall strictly adhere to the drawings and specification. Before submitting his tender, the Contractor must carefully and thoroughly examine the drawings and specification as no allowance or claim will be considered for any alleged deficiency or materials and should any work or materials obviously necessary to complete the work have been omitted to be defined in the specification such work or materials are to be provided without any additional payment.

Should any difference exist between the drawings and specification or should there be any discrepancy in the figures, scales or in other respect, the Contractor must refer to the Engineer before proceeding with the work and the decision of the Engineer shall be conclusive.

The drawings are diagrammatic only, and the Contractor must obtain his own detailed measurements and be entirely responsible for their accuracy. Equipment shall be located where shown on the contract drawings, but where positions are shown diagrammatically on the drawings or diagrams, the exact location shall be agreed with the Engineer before commencement of installation.

1.5 Tender Basis

Tenders shall be submitted on a fixed price basis, with any fluctuations in the cost of materials and/or labour will be deemed to be included. The defects Liability period shall be twelve months.

1.6 Safety and Welfare Measures

The Contractor will be responsible for providing and maintaining all general measures which under or by virtue of the provisions of any enactment or regulation or the working rules of any industry are required to be taken for the welfare and safety of workpeople employed on the site.

1.7 Programme

The contractor will be required to plan the execution of the whole of the Works to suit the Trust's requirements using either a bar chart or a network analysis. In this connexion the Contractor shall ensure that he is able to provide such information as may be required.

All costs involved, both initially and at the required intervals throughout the Contract, of the necessary programming and progress details of the Contract shall be deemed to be included in the Contractor's tender.

1.8 Schedule of Rates

In addition to the requirements set out in the invitation to tender, the contractor shall submit to the Engineer a schedule of unit rates with quantities used in the compilation of his tender. The schedule of rates must be signed by the sub-contractor and the total of all rates and quantities shown must equal the tender sum submitted by the contractor for that part of the whole of the works to which it applies. This schedule of rates will be used during the execution of the contract to price all variations.

1.9 Incidental Work

The Contractor is to provide for the performance of all incidental matters which may reasonably be inferred from the drawings and/or specification, in order to leave the work perfect and complete, although the same may not be expressly mentioned therein.

1.10 Site Visit

The Contractor will be deemed to have visited the site and examined the drawings and made himself thoroughly acquainted with all details not specially mentioned herein or shown upon the drawings, including the access for all materials and apparatus, previously to submitting his quotation. No additional payment will be made in respect of any claims arising from the Contractor's lack of appreciation of site conditions.

1.11 Electricity for Construction Purposes

The Employer will provide power to enable the work to be carried out. The tenderer should satisfy himself that the provision made is adequate to safely and satisfactorily carry out the works. The electricity supply will be at 240 volts 50 Hz and the Contractor will need to provide any low voltage transformers required for the operation of his power tools, and shall observe any load restrictions imposed by the Employer.

1.12 Water for Construction Purposes

The Employer will supply clean fresh water for the use of the Contractor.

1.13 Fire Precautions

The Contractor shall take all reasonable precautions to prevent loss or damage of lands and property occasioned by fire. No fires shall be lighted for any purpose in connexion with this contract. No hot work (*e.g.* welding) shall be carried out without the agreement and with adequate prior notice of the Engineer. Under no circumstances shall hot work be undertaken within one hour of the Contractor leaving the site.

The Contractor shall allow for heat-resisting mats and/or heat sinks to be used to prevent fire and damage to other materials. Include for the provision of two portable fire extinguishers located in the immediate vicinity for emergency use and suitable for the type of hazard present.

The Contractors shall comply with the Employer's Safety Rules. When employed within certain areas of the Site, the Contractor may be required to comply with a Permit to Work system.

1.14 Noise Control

The Contractor shall ensure that all measures to control the noise levels produced by his operations on site required under or by virtue of any enactment or regulation, or the working requirements of the Employer, are strictly complied with. No radios or other audio equipment are allowed on site.

1.15 Advertising

The Contractor shall not display, or permit to be displayed, any advertisement on the Site or any other land to which he has access under the Contract, neither shall he publish or broadcast or allow to be published or broadcast any advertisement, article, drawings, photographs or interview concerning the Works without the written authority of the Employer.

1.16 Copies of Orders for Materials

When so required by the Engineer the Contractor is to forward copies of all orders placed for raw or fabricated materials, equipment or commodities to be used in the permanent work in this contract at the time of placing such order.

1.17 Offsite Inspection

The Engineer shall be entitled at all reasonable times during manufacture to inspect, examine and test on the contractor's premises the materials and workmanship of all Plant to be supplied under the Contract and if part of the said Plant is being manufactured on other premises the Contractor shall obtain for the Engineer permission to inspect, examine and test as if the said Plant were being manufactured on the Contractor's premises. Such inspection, examination or testing, if made, shall not release the Contractor from any obligations under the Contract.

1.18 Quality of Materials and Workmanship

All goods, materials, plant and equipment shall be new, of proven reliability and well established design, of the best quality and shall comply with all the relevant British Standards and British Standards Codes of Practice as published by the British Standards Institution. The workmanship shall be to the highest and the whole shall be to the approval of the Engineer. All proprietary items shall be to the approval of the Engineer and the Contractor shall be responsible for any delays caused by the submission of unacceptable details in connection with such approval

1.19 Options of Materials

Manufacturers' names are given in this specification to indicate the standard of materials required, and for the purpose of the tender the Contractor must include the manufacturers specified.

He may, however, if he desires offer alternative manufacturers of equal standard, but must submit with his tender a full list of materials varying from the type named in this Specification and quote the change in prices which the substitution involves. In all instances, prior written approval must be granted by the Engineer before such alternative materials are used.

1.20 Calculations and Drawings to be Supplied by the Contractor

The Contractor must at his own expense supply to the Engineer all design calculations and detail drawings which may be required for the erection of the work. These generally will be referred to in the Specification or on the Contract Drawings, but the Contractor should confirm, with the Engineer if any additional calculations and drawings are required.

Single copies of all such calculations and drawings are to be submitted for approval before the work is put in hand. The approval of such drawings covers only the general principles of the work concerned and is not to absolve the Contractor from carrying out the work according to the full extent, meaning and spirit of the specification. Drawings of any amendments to the work, extras, or other diversions to which approval is given from time to time as the work proceeds, shall also be supplied by the Contractor.

1.21 Setting out of Work

The Contractor shall accurately set out the works and keep them correct in accordance with the drawings and to the approval of the Engineer. Where services to be installed under this contract are to be run adjacent to or near to other services, the setting out of the services is to be approved by the Engineer before installation proceeds.

The Contractor shall be responsible and shall at his own cost amend any errors arising from his inaccurate setting out, unless the Engineer shall otherwise direct.

1.22 Dimensions to be Taken on Site

The Contractor shall take his own dimensions on site for all plant and materials to be supplied by him and shall be entirely responsible for their accuracy.

1.23 Keep Site Clean

The Contractor shall keep the site free from rubbish etc, surplus materials etc, arising from the execution of his contract. At the completion of each working day, he shall leave every part of the work in a sound and perfect condition, clear away plant etc in connection with the work and leave the premises clean and tidy all to the entire satisfaction of the Engineer.

1.24 Site Meeting

Meetings will be held on the site as required by the Engineer and the Contractor shall arrange to have a responsible representative at each meeting.

1.25 Scaffolding and Plant

The Contractor shall be responsible for providing any scaffolding and plant required for execution of the contract work and for the provision of any specialist trades or equipment he requires.

1.26 Use of Site by Contractor

An area of the Site will be set aside as a working area for the use of the Contractor and his employees for the exclusive purpose of carrying out this contract. On completion of his work the Contractor shall remove all his construction plant, temporary work and surplus materials and leave the area in good order to the satisfaction of the Engineer.

1.27 Temporary Screens

The Contractor shall be responsible for the provision, maintenance and removal of all temporary screens which may be required to isolate his working area from the working areas of the Employer.

1.28 Unloading and Hoisting

The Contractor will be required to provide his own facilities for the unloading, placing in the removal from store and hoisting of all materials and plant.

1.29 Existing Services

No existing service may be isolated/shut down or otherwise interfered with without the agreement of the Engineer and the Employer. The Contractor shall advise the Engineer in writing, giving not less than 24 hours notification of his request for an existing service to be shut down and/or isolated.

1.30 Temporary Services

The Contractor shall include for the provision, maintenance and removal of any temporary or jury electrical or mechanical services necessary for the Employer's premises to remain functioning while the works proceed.

1.31 Builders Works

The Contractor shall allow for all associated builders works required to enable him to complete the project, e.g. holes, temporary screens, brickwork and plasterwork, scaffolding, decorating, making good etc shall be included.

The contractor shall ensure all dust, slurry or other debris resulting from drilling is captured at source or otherwise prevented from causing injury, damage or nuisance to personnel, equipment, furnishings etc.

1.32 Mechanical and Electrical Works

The Contractor shall allow for all the mechanical and electrical works required to enable him to complete the project, e.g. ductwork, traywork, trunking conduit, pipework, electrical wiring, etc. All making good to disturbed existing services should be included.

1.33 Co-ordination

The Contractor shall be responsible for co-ordinating his works and where necessary he shall provide co-ordination drawings, in liaison with other contractors. All drawings shall be submitted for the Engineer for approval.

1.34 Trespass and Damage

The Contractor shall prevent any trespass on any adjoining owners' property. No steps, ladders or other plan shall be left accessible for unauthorised persons to enter the building.

The Contractor shall take all reasonable precautions during the progress of the contract works to prevent any damage to the Employer's or adjoining properties and to prevent materials, rubbish, debris etc collecting thereon.

The Contractor shall regulate the character of transport and so operate it as to ensure that no damage beyond fair wear and tear is occasioned thereby and shall comply with the requirements of the Engineer as to routes to be traversed and limitations of weights, speeds and class of vehicles.

1.35 Overtime, Shift Working and Nightwork

To gain access, and/or to reduce the effects of installation on the working areas of the Employer's properties, the Contractor may be required to arrange part of his working either after 5 pm or before 8 am or at weekends. No additional payment shall be made in respect of any costs of overtime, shiftwork, nightwork or weekend working so required. The Contractor shall be deemed to have included in his tender price for all such overtime, shiftworking, nightwork and/or weekend working.

1.36 Labels

Labels, in English and Welsh or showing a suitable symbol, shall be fitted to all items of plant and equipment, including panels, boards, valves, instruments, control equipment etc.

1.37 Commissioning Specialist Items of Plant and Equipment

The Contractor shall allow in his tender for any attendance necessary during the commissioning of the specialist items of equipment, for which he is responsible either whole or in part.

1.38 Certification of Completion

As soon as the Works have been completed in accordance with the Contract (except for minor defects that do not affect their use for the purpose for which they are intended) and except for the maintenance therefore as provided for in the Conditions of Contract the Engineer shall issue a Certificate of Practical Completion in which he shall certify the date on which the Works have been so completed and have passed the specified tests, but the issue of such a Certificate shall not operate as an admission that the works have been completed in every respect.

Any defects listed on the certificate shall be rectified by the Contractor to the standard required by the specification without delay.

Section N° 2

Materials & Workmanship – Mechanical

2.1 General

All materials used in connection with work covered by this Specification shall be new and obtained from approved manufacturers. Preferred or approved manufacturers are given in this Specification and, unless otherwise stated, Contractors will be required to supply materials of a type and manufacture as indicated.

Where the Contractor is instructed to employ materials supplied through other Contractors, or from other sources, or is instructed to re-use existing material supplied by the Trust he will be responsible for satisfying himself that the material is in good working order, is suitable for the use intended and for notifying the Engineer if, in his opinion, the material is unsuitable for reasonable application, in accordance with his instruction. The decision of the Engineer shall, however, be accepted as final.

The Contractor shall not isolate, disconnect or otherwise interfere with any part of any existing mechanical installation or carry out any part of any existing installation without first obtaining the approval of the Engineer.

All work shall be carried out in such a manner as to ensure the installation and its associated apparatus will not be impaired or damaged due to the presence of other services in the vicinity. Special attention shall be paid in situations where there is any possibility of delayed damage to the installation arising from the proximity of hot pipes or apparatus, the presence of vapours or liquids or the existence of any conditions which is outside the performance limits of the materials employed.

2.2 Pipework Installations

Quality of Installation: Installation shall be to specifications and comprise new material assembled to a high standard of workmanship under the supervision of qualified personnel. Sub-standard work will not be accepted and the following clauses list example of materials and work that will be rejected.

- (a) The use of damaged parts, incorrect types, sizes, standard, materials, marking etc.
- (b) Carbonaceous residues left in the bores of copper pipes by the manufacturer.
- (c) Damage to parts caused by carelessness, tools, soldering, brazing, welding etc.
- (d) The use of long screws, back-nuts or reducing bushes.
- (e) Pipes not cut clean and square with the axis or devoid of burrs, or pipes cut with level wheel cutters.
- (f) Pipes or fittings with broken or damaged threads and more than 3 threads extending beyond fittings when screwed up.
- (g) Joints maligned or distorted and not true with pipe axis.
- (h) Pipework runs without the required gradients.
- (i) Pipes supported from other pipes or not capable of individual removal without disturbing other pipes.
- (j) Maligned or distorted supports, fixings and pipework.
- (k) Insecure supports or restrictive of proper expansion, contraction, or lateral movement as required for the pipeline or branch pipe used as supports for risers.
- (l) Pipes supported on the sleeve of fire stopping, or the fire stopping not fitted or to the required Fire Authority standard.
- (m) Bores of pipes and fittings which are blocked or contaminated by foreign matter.

-
- (n) Eccentric fittings assembled the wrong way up - the taper should rise in the direction of the flow.
 - (o) Valves difficult with difficult access for operations or maintenance.
 - (p) Any items not installed in accordance with the manufacturer's recommendations.
 - (q) Disregard of the requirements for preservation of water quality including use of pastes, compounds, greases or lubricants, on joint faces of hot and cold water services.
 - (r) Inadequate protection against electrolytic actions.

Other faults may also applying including any disclosed by weld inspections, testing and commissioning.

2.3 Pipe Ends and Cutting

Pipes shall be cut clean and square with the axis by machine, pipe cutter or saw as appropriate to materials but not by flame cutting or bevel wheel cutter.

They shall be prepared for capillary fittings on copper or stainless steel pipes by deburring and chamfering.

Steel pipes shall be prepared for threading by removing burrs. Preparation for butt welding steel pipelines shall include machining heads and removing burrs.

Plastic pipes shall be prepared in accordance with the manufacture's instructions, the exact procedure being appropriate to suit solvent or heat fusion technique employed.

2.4 Screwed Threads

Screwed threads shall be to B21 taper on pipes and adapters. They shall be cut clean, concentric and unbroken with all oil, scurf etc, removed.

Threaded connections on copper or stainless steel pipes shall be provided by means of capillary screwed adapters, with a limit of 2" BSP maximum.

Any exposed threads of mild steel pipes, visible after the fitting has screwed on will immediately be painted as installation proceeds.

Screwed thread joints on hot and cold water services shall be made pressure tight by means of PTFE (Polytetrafluoroethylene) tape only and without the use of pastes hemp or similar materials.

2.5 Thread Sealants

All domestic hot and cold water services: Polytetrafluoroethylene (PTFE) tape which has passed Water Research Centre tests as suitable for potable water and proof against bacterial growths *ie* PTFE unsintered tape applied with 50% overlap to BS 4375 for thread 2" BSP and below or jointing materials to BS 5292 and BS 6956 Parts 1,5,6 and 7.

Hemp or any jointing compound involving the use of hemp shall not be acceptable.

Heating services: A jointing compound together with hemp, alternatively PTFE tape may be used. The finished joint shall be left clean with no trace of hemp or compound visible.

Natural Gas Service: Shall be approved by British Gas: documents No IM/16 i.e. PTFE unsintered tapes applied with 50% overlap to BS 4375 for threads 2" BSP and below, the tape quality being subjected to pressure tests or, be wound on spools marked '*satisfies BGC/IM/16*' and states wrapping technique and sizes of pipe for which it is it is suitable.

For other services: Comprise PTFE type as cold water service for steam 1½" BSP and below or 2" BSP and below for other services.

2.6 Pipe Unions, Flanges and Joints (Gaskets)

Unions shall be limited to a maximum size of 2" BSP under otherwise specified in a particular service section. They shall be assembled without the use of lubricants on the joint faces when

used on hot and cold water services, and on no service are joint pastes or compounds to be used. Flanges shall be provided on pipes 2½" diameter and above, also on smaller pipes where specified in a particular service erection of this Specification.

They shall be screwed or welded true and square with pipe axis on steel and ductile iron pipes. Flanges shall be of the composite type for copper, stainless steel and plastic pipework. For plastic pipework the flanges shall be solvent welded or heat welded as appropriate.

Joints (gaskets) shall be free of all asbestos materials and full face the materials generally as recommended by the manufacturer's to suit the service conditions.

Joints for flanges on hot and cold water services shall be from ethylene polyene synthetic rubber as approved by the Water Research Centre suitable for potable water and proof against bacterial growth.

All flanged joints shall be assembled without the use of pastes or compounds.

2.7 Pipe Runs Gradients, Break Points

Pipe runs shall be generally parallel with walls on horizontal runs and set neatly round piers and projections where a good appearance is required.

They shall be set plumb and without offsets on vertical runs.

Pipe runs shall be so configured as to avoid the presence of any joints within the thickness of any wall floor, ceiling or other part of the building structure, nor shall pipes be embedded in walls or floors.

Arrange all pipe runs with adequate clearance from walls and ceilings to permit easy access to valves.

All services shall be graded to rise or fall in the directions of flow at 1 in 250, except for gravity condensate and drainage from air handling units, which shall be graded at 1 in 100.

Pipe runs shall be provided with the following break points - unions on pipes 2" diameter and below flanges above at the following positions:-

At each branch form headers, mains and risers.

At connexions to plant and equipment.

At 18m intervals for unions and 10m for flanges.

Provide isolating valves at connexions to plant, equipment headers etc as shewn on the drawings or as specified for specific services. A screwdriver operated ball valve shall be fitted within 12" (300mm) of sanitary fittings.

2.8 Open Ends of Pipework

All open ends of pipework shall be temporarily sealed by means of purpose made plugs, blanking caps or blank flanges during erection, including valves at the end of pipework runs which shall be closed and sealed.. Plugs formed from waste or of wood shall under no circumstances be used.

All pipes stored on site shall be under cover and clear of the ground and care shall be taken to prevent dirt or rubbish entering ends of pipework during storage and erection.

2.9 Pipework Clearances and Segregation

The minimum clearances between uninsulated pipes, finished face of insulation on insulated pipes and adjacent surfaces shall be as follows:-

Walls	1"	25mm
Ceilings	4"	100mm
Finished floors	6"	150mm
Adjacent pipes both insulated	1"	25mm
Adjacent pipes both uninsulated	1"	25mm
Adjacent pipes only one insulated	3"	75mm

Insulated pipes only adjacent to conduit or trunking	4"	100mm
Uninsulated pipes adjacent to conduit or trunking	6"	150mm
Uninsulated pipes adjacent to electrical cables not in conduit or trunking	6"	150mm
Insulated pipes adjacent to electric cables not in conduit or trunking	4"	100mm

The spacing of services shall provide for the application of thermal insulation and flange and valve muffers or boxes. The spacings given above will be revised as necessary to accommodate pipeline fittings and to provide easy access to pipes and electrical services for installation maintenance and inspection.

The layout and segregation of the services is to be, as far as possible, in accordance with BS 813, this is particularly applicable to the service runs within ducts.

Cold water pipes are to be spaced from and below hot pipes to minimize heat gain.

2.10 Sleeves and Cover Plates

Sleeves shall be provided for pipes passing through walls, floors and partitions. They shall be in the case of metal pipes be of similar material to the pipe, but copper or steel for plastic pipes.

The sleeves shall be generally one or two sizes larger as necessary, and positioned true around the pipe to provide adequate clearance and sufficient to allow for lateral movements of the pipework if required.

Sleeves through walls shall protrude 2mm beyond the finished surface of the wall, those passing through floors and ceilings shall have a supporting flange at one end, or be fitted with locating lugs. In both cases the screws shall be provided with chromium plated or stainless steel cover plates of an approved pattern. However, in laboratories, cloakrooms, kitchens and other wet areas, to avoid flooding omit the floor cover plate and extend the sleeves so that they stand 3" (76mm) proud of the finished floor level. The outer edge of the sleeve shall be rounded or bevelled and the annulus gap sealed with waterproof mastic.

The gap between pipe and sleeve shall be stopped in all fire rated structures to Building Regulations Approved Document B - Fire Spread - this shall be an asbestos free material approved by the Fire Authority and which will not restrict pipework movement.

Generally the thermal insulation shall be stopped short each side of the wall or barrier. However, in the case of chilled water pipes, and any other services as detailed elsewhere in this Specification; the sleeves shall be oversized to enable the insulation to be carried continuously through non-fire rated walls or partitions.

2.11 Pipe Fittings

Pipe fittings shall be low resistance type bends, swept tees etc. Square type fittings may only be used on final draw off pipe, pipe runs and if necessary at high level to facilitate venting and draining, or at steam trap sets for venting or draining.

All fittings shall be the same size as the pipes connected to them. Bushed outlets will only be accepted if the required outlet size of fitting is not a standard size. Eccentric reducing sockets will be used where changes in bore are made in runs of nominally horizontal pipework to facilitate air venting and draining. Concentric reducing fittings shall be used on vertical risers.

Banded, beaded or plain fittings may be employed, but the types shall not be 'mixed' on any installations. In the case of refurbishment or the extension of existing installations, the fittings shall match those already extant.

Beads may be made on a beading machine or beading spring, (up to 20mm copper), alternatively fire sets may be used. Tight radius beads in micro diameter pipes shall be made using the manufacturer's recommended tube bender. Care must be taken to avoid any reductions of cross-sectional area of the pipe or rippling of the throat of a band which will make such a bend unacceptable. Bends formed by hand or by machine bending shall have a centre line radius equal

to not less than three times the pipe bore. Where double sets or precision beads are required, these shall be formed to the correct dimensions for insertion into the pipework as required without strain or change of form.

Machine made or fore set bends will not be permitted on galvanised pipework unless the pipework is to be galvanised afterwards.

2.12 Draining and Venting

Throughout each installation particular attention must be paid to venting and drainage.

Drainage points shall be provided at all low points in water systems to facilitate complete and rapid emptying down and at branch valves immediately downstream to facilitate maintenance of the branch. Unless shewn otherwise, drainage cocks shall be loose key operated to BS 2899 lockshield pattern complete with hose connexion, and supplied with three loose keys for each size of drain cock fitted.

All high points shall be fitted with air bottles where self-venting through the mains or taps cannot take place or would not prove satisfactory. The air bottles shall be comprise a square branch the diameter of the pipe being vented, connected to an air bottle formed from 50mm tube, not less than 250mm long, or size agreed with the Engineer, fitted with a cap and discharge pipe.

The bleed pipe shall be run in 8mm copper to BS EN 1057 R250/R220 and be exposed to view. It shall run from the top of the bottle to a convenient position 1.4m above floor level terminating in an 8mm gunmetal needle seat type air valve with loose keys.

Automatic air eliminators shall be fitted to an equal square tee on the main, together with the necessary reducers. They shall have gunmetal or brass bodies, non-ferrous floats and guides, and non-corrodable valves and seats.

Drain and vents shall be fitted at all necessary points whether shewn on the drawings or not.

2.13 Pipe Supports

Pipe supports shall be generally to the following standards:-

BS 1494 Part 1 for pipe clips, brackets etc

BS 3974 Part 1 for hangers, slides and rollers

BS 3974 Part 2 for clamps, cages, cantilevers and beam attachments

The Contractor is to provide all necessary steel sections, fittings, nuts, bolts, building clips, rollers and chairs etc for the formations of suitable supports, anchors, sleeves, hangers and other supports throughout the installations. Special attention must be paid to this matter, particularly in the case of pipes located in ducts, vertical risers and other long lengths of pipes. The designs must allow for the free movement of pipes at all points save at anchors where a device must be arranged for positively holding the pipe so as to prevent movement. Pipes must be able to expand and contract freely within the design figure and in the intended direction without overstressing pipes, joints or connexions to equipment.

Supports shall be provided at the base of vertical pipes, bends, tees, flanges, unions, changes of direction, each side of valves in addition to the normally spaced supports on vertical and horizontal pipe runs. Supports shall be arranged to carry each pipe run independently of any others to permit differential expansion and maintenance without disturbing adjacent pipes.

Pipes shall be provided with oversize load bearing insulation blocks on the following services:-

Steam, condensate MTHW and HTHW pipes of all sizes.

Chilled water and refrigeration pipes of all sizes.

Cold water pipes if the thermal insulation is vapour sealed.

Table of Maximum Spacings for Pipework Supports

Nominal	Horizontal Springs - metres			Vertical Springs - metres		
	Steel or	PVC or	Copper	Steel or	PVC or	Copper

pipe size	iron pipes	ABS pipes	stainless steel pipes	iron pipes	ABS pipes	stainless steel pipes
½" 15	1.8	.9	1.2	2.4	1.2	1.8
¾" 20	2.4	1.0	1.2	3.0	1.5	1.8
1" 25	2.4	1.1	1.5	3.0	1.5	2.4
1¼" 32	2.4	1.2	1.8	3.0	1.5	3.0
1½" 40	2.4	1.2	1.8	3.7	1.8	3.0
2" 50	2.4	1.2	1.8	3.7	1.8	3.0
2½" 65	3.0	1.5	2.4	4.6	2.3	3.7
3" 80	3.0	1.5	2.4	4.6	2.3	3.7
4" 100	3.0	1.5	2.4	4.6	2.3	3.7
5" 125	3.7	2.0	3.0	5.5	2.7	3.7
6" 150	4.5	2.0	3.7	5.5	2.7	3.7
8" 200	6.0	2.5	-	8.5	4.2	-
10" 250	6.5	-	-	9.0	-	-
12" 300	7.0	-	-	10.0	-	-

2.14 Expansion Loops, Joints, Guides and Anchors

Wherever possible advantage shall be taken of changes in direction of mains to accommodate expansion, but where this is impracticable expansion devices are to be used.

In the case of steam and condensate, MTHW and HTHW mains, otherwise specified, the excess expansion shall be absorbed by means of expansion loops, either horse-shoe or lyre loops. They are to be manufactured from the same material as the pipe with additional thickness to allow for bending without undue thinning and formed in one length with flanged ends, or fabricated from straight length of pipe and short radius elbows.

Excess expansion present in LPHW and domestic hot water systems shall be absorbed by means of articulated expansion bellows.

With either arrangement, the associated guides and anchors must be provided. In the case of commercial bends or bellows the exact guides and anchors proposed must be approved by the manufacturers of the expansion device.

The Contractor shall provide and fix pipe anchors where indicated on the drawings and wherever necessary to prevent accumulation of expansion. Pipe anchorage points shall be fixed positively to the pipe by bolting and spot welding and are to be made on a short length of pipe flanged at each end.

Anchors shall not be positioned within 600mm of welded joints on steel pipes and secured so that the pipe is not deformed or overstressed by clamps or where welded or brazed attachments are made.

Guides shall be incorporated at all roller and slider supports and provided at expansion joints. They shall be capable of adjustment to give the correct alignment of the pipework and device before being rigidly fixed.

The type and positions of all expansion joints and anchor points shall be approved by the Engineer before installation.

2.15 Buried Pipework

Buried pipework shall in the case of cold water pipes be copper or polyethylene laid at a depth of between 1000mm and 1350mm to the top of the pipe to suit local conditions and to avoid freezing.

In the case of gas pipes, they shall be laid in accordance with the recommendations of Section No.8, at a depth of not less than 60mm.

The pipes throughout the length of either service, shall be laid on a bed of well rammed clean sand of at least 100mm thickness, with the sides of the trench clean of rocks or any other projecting debris.

Cover the pipes by another layer of sand 100mm thick after laying. Back fill the trench with the excavated earth well rammed down. Not more than 150mm of soil to be rammed down at one time. Lay one or more proprietary plastic warning marker tapes along the pipe run during back filling and positioned 300mm below ground level.

In the case of polyethylene gas and cold water pipes a copper conductor shall be strapped to the pipe for future location. Each of the copper conductors shall be terminated in convenient, accessible, protected location so enabling a specific tracing signal to be applied if required.

External buried water pipework shall be carried out using pale blue MDPE with mechanical joints. Buried gas pipework shall be carried out in yellow MDPE pipework employing mechanical (2"/63mm dia. & below) or fusion welded joints. The installation shall be to a high standard carried out by skilled workers experienced in this work, and in particular, fully trained in heat fusion jointing techniques where this method of pipe jointing is used. Use electrically powered tooling and equipment to BGC/PS/PL.2 Part 3.

Where a buried MDPE gas supply is to enter a building it shall terminate approximately 1 m from each building and be continued in steel pipework, so that the entry into the building is effected in steel. At the point of change in pipeline material fit an isolating valve. The valve shall be key operated and located inside a guard concrete chamber with surface box to BS5843 Parts 1,2 and 3. Buried steel pipework shall be heavily protected against corrosion by being wrapped in a double layer of Denso paste and tape.

2.16 Markers for Buried Pipework

Where stipulated in Section N° 8, or on the drawings, small markers shall be provided at 50m intervals along each run on straight sections, at all changes of directions and at each side of roadways. They shall consist of a reinforced concrete posts, bearing non-corrodable and durable plates having permanent tethers and markers stamped or cast on stating:-

Pipe size in mm	eg 125 Ø
Service	eg Gas
Depth of Service	eg 600

The plates shall be secured to concrete marker posts in unmade ground and to flush concrete blocks in lawns, verges or pavements.

Plates shall be attached to buildings at the point of entry of a service. In the case of services running parallel to buildings state the distance from the plate to the service. The marker plates shall be indelibly marked with the word Gas or the letter G. The marker plates shall also be marked with the letter V, S or PP to denote valve, syphon or purge point respectively.

The covers or lids of valve chambers for buried services shall carry indelibly cast lettering describing the service.

2.17 Welding of Low Carbon Steel Pipework

Welding shall be in accordance with the recommendations in HVCA Code of Practice TR/5 for pipe not exceeding 200mm size and 20mm wall thickness and to be Class II by electric arc process to BS 2971 using welding materials to BSEN 499 for pipe exceeding 200mm size and 20mm wall thickness.

Oxy-acetylene welding will not be acceptable for pipework over 100mm diameter or pipe flanges for any size.

Welding shall be utilized for all joints in steam, condensate, steel chilled water, and heating services located in boiler rooms, plant rooms, tank rooms, ducts and concealed spaces together with services run externally or in ceiling voids.

Welders shall only be employed in the work on or off site provided that they hold a correctly valid Heating, Ventilating and Domestic Engineers National Joint Industrial Council's Certificate

of Competency for Oxy-Acetylene welding Grade 'A' or Metal Arc welding as appropriate to the work in hand or alternatively a currently valid welders performance certificate issued by the Associated Officer Technical Committee.

A welder will not be allowed to continue welding on or off site if his standard of workmanship proves to be unsatisfactory.

In addition to the requirements of BS 2971 and HVCA Code of Practice TR/5 the work shall have standard fittings to BS1965 Part 1 without the use of segmented or cut-and-shut bends.

The welding of each weld run of a welded joint shall be continuous, with cleaning and inspection by the welder before a further run is applied.

No welding shall be done in extremely cold or severe weather conditions which would affect weld quality.

Faulty weld sections shall be removed and made good by welding-in lengths of pipe not less than 300mm long subject to the supervisor/inspectors instructions.

All branch welds will be made by the set-on method, with the centres of adjacent branch welds at a distance of not less than twice the diameter of the largest pipe as a minimum, in conjunction with a suitable gap between flanges.

No welded joints are to be located within 600mm of an anchor point or pipeline guide.

The end faces of pipes and fittings are to be machined and bevelled - not flame cut - at right angles to the axis of the pipe bore.

Weld-on flanges are to be provided at maximum intervals of 10 metres to provide break points, whether shown on the drawings or not.

The joint faces of each pipe within 25mm of the face is to be completely cleaned to remove all foreign matter before welding and on completion of the welds cleaned round the joint for the visual inspection procedure. Joints to be finally cleaned and primed within 4 hours of the inspection, or after satisfactory NDT testing.

When visual tests on completed work indicate that the quality of welding could be below specification then the Engineer shall be entitled to have the welder examined and non-destructively tested at the Contractor's expense.

Protection of Persons and Material From Weld Damage

Protection shall generally be in accordance with Health and Safety Executive Booklet No.32 (Electric Arc Welding) and shall include:-

Opaque screens to be used and positioned around fusion operations to prevent weld flash being visible to persons other than the welder.

Include for heat-resistant mats to be used to prevent fire and damage to other materials during the welding process.

Include for the provision of two portable fire extinguishers located in the immediate vicinity for emergency use and of suitable type for the nature of the hazard present.

The employment of mechanical extract ventilation where an unacceptable concentration of fumes may occur.

Carry out a risk assessment for welding processes in each location.

2.18 Capillary Jointing of Copper or Stainless Steel Pipework

Capillary Soldered Joints Shall be to BS864 Part 2 using integral ring fittings with lead free solder and marked accordingly, for hot and cold water services and for all other services to standardise on site inspection requirements. The joints shall be made using the correct grade of flux to suit the service requirement as specified.

Capillary Brazed Joints: Shall be to BS1723 Part 1 and BA 1306 and made in accordance with the recommendations of HVCA Code of Practice TR/3. Bronze welding of fittings will not be permitted.

Joints shall be made using the correct grade of silver brazing alloy and flux to BS 1845 to meet

the service conditions are specified and to meet the requisites for portable water quality in the case of hot and cold water services.

Where brazing of copper take to heavy duty gunmetal/bronze fittings using a copper-silver zinc brazing alloy to BS1845 Type AG4 or AG20 is specified, the process is to be carried out under controlled conditions and in clean conditions suitable for use appropriate to the service intended, with no traces of flux, grease or other matter on the completed items. The flux shall be as recommended by the manufacturer.

Where applicable, joints shall be tested in accordance with BS1723 Parts 1 & 3 and HVCA Code of Practice TR/3 and BS 443.

Precautions/Hazards During Brazing: The Contractor is reminded that under the terms of the Health and Safety at Work Act 1974, brazing and soldering present health risks, not only the explosion risks from oxygen and fuel gases, but also from the vapours released by having cleaning solvents, fluxes and over heated filler metals etc.

The Contractor shall ensure that the area of operations is safe for carrying out the work involved and free from combustible waste materials etc. He shall provide adequate heat shielding and where necessary heat sinks.

The Contractor is to notify the Client on a daily basis if any hot work is to be carried out in any void, duct, unoccupied space or any other concealed site advising of its locations and likely duration. He shall again report to the Client on completion of hot work each day conducted in such locations.

The Contractor must comply with all of the Client's Safety Rules, which may encompass a permit to work system, and shall acquaint himself and his staff with the Client's fire drill procedures.

At all times, and irrespective of location, no hot work shall be performed within 1 hour of leaving site, and two portable fire extinguishers shall always be present suitable for the nature of the hazards present. The Contractor will be responsible for ensuring adequate ventilation of the work area, confirm that all workers are aware of the dangers of the misuse of oxygen for ventilation purposes and ensure there is adequate means of escape from confined spaces.

The Contractor shall carry out a risk assessment of each room/location.

2.19 Provision for Testing, Commissioning, Instrumentation and Controls

All necessary connexion points for testing, commissioning, instrumentation and control shall be included as pipework is erected. Positions generally are shewn on the drawings and the details should also be agreed with the commissioning engineer including the positions of regulating valves.

Test plugs are to be of the self-sealing type with brass bodies having captive blank closing caps screwed on.

Thermometer pockets are to be to BS 2765 Part 1 and Part 2, (of brass, non-dezincifiable on hot and cold water services) screwed BSP thread and filled with heat conducting grease.

Provide connexion points for chemical dosing where shewn.

Suitable bosses shall be welded or brazed onto the pipes and screwed to suit pockets, gauges, sensors etc to the details shewn on the drawings or otherwise specified. The Contractor is to fit all such controls or test equipment to the pockets/bosses.

All work involved in attaching the bosses and drilling and screwing is to be done before the pipework length is installed, so that all oil, swarf, etc can be completely removed.

Test and purge points on Natural Gas pipework are to be provided in accordance with British Gas Standard IM/2 and IM/5.

2.20 Protection of Services

Protection of initial piped services shall be ensured by not installing any pipework until the building envelope is reasonably weathertight/waterproof in order to protect the services from

corrosion.

2.21 Valves for Domestic Hot & Cold Water Services

Generally and unless otherwise stated on the drawings or specification valves for domestic hot and cold water services shall be from the following:-

Thermostatic mixing valves	To comply with NHS/TMV3.
Gate valves	Hattersley Fig 33 x DZRC or equivalent.
Stop cocks	Bronze/gunmetal Lockshield pattern BSS. Fig 551LS or equivalent (Yorkshire “Kuterlite”).
Regulating cocks	Lockshield brass BZR bodies.
Ball Isolating Valves	BSS Fig 963S lever operated or equivalent. BSS Mini Ball or equivalent.
Taps	See drawings and specification for details.

The Contractor shall supply and fit whether shewn on the drawings accompanying this specification or not all necessary valves, stopcocks and drain cocks, strainers etc, for the correct operation, regulation and maintenance of the various piped systems. Lockshield valve keys shall be provided for each size of gunmetal valve and handed over to the Engineer.

Automatic air vents shall have gunmetal or brass (DZR) bodies non-ferrous or stainless steel floats and guides and non-corrodible valves and seats. Drain-cocks shall be of gunmetal or brass (DZR) with non ferrous internals and outlet ribbed for bore connections.

Safety and relief valves shall be bronze as manufactured by NARBIC factory set to operate at the maximum safe working pressure. Test certificate shall be forwarded to the Engineer.

2.22 Valves for Low Pressure Hot Water Heating

Generally and unless otherwise stated on the drawings or specification, valves for the LPHW heating services shall be from the following:-

Safety and relief	Bronze	NARBIC
Radiators		
TRV	Brass	Danfoss RA2000 series with in general horizontal angle (UK pattern) valve bodies.
Balance	Brass	Danfoss RLV – commercial.
Double regulating & metering	Bronze	Crane D941 or Hattersley to match existing.
Gate	Bronze	BOSS Fig 25 SM or equal.3" dia & above cast iron - Crane Fig F52 or equal.
“Balanced Pressure”	Bronze	Danfoss AVDO ½” & 1” diameter.
Automatic balancing	Brass	Crane type D960.
Draincocks & lockshields	Brass	Yorkshire “Kuterlite”.
Three port	Brass	Satchwell type MB.

Automatic air vents shall have gunmetal or brass (DZR) bodies non-ferrous or stainless steel

floats and guides and non-corrodible valves and seats. Drain-cocks shall be of gunmetal or brass (DZR) with non ferrous internals and outlet ribbed for bore connections.

Safety and relief valves shall be bronze as manufactured by NARBIC factory set to operate at the maximum safe working pressure. Test certificate shall be forwarded to the Engineer.

2.23 Natural Gas Service

Generally, and unless otherwise specified on the drawings and specification, internal valves on the natural gas service shall be non-lubricated full bore ball valves. BOSS Fig 9665 or equivalent. The size and positions will be as shown on the drawings.

Gas service valves shall be of the ball type, lever operated, to open or close with a 90° turn of the handle. The valve to be closed when handle lies at right angles to the pipe run; valves shall have a yellow handle.

2.24 Labels

The Contractor shall supply and fix labels to all valves and stop cocks on all main and sub-circuits, dampers, control valves, controls and switches, wherever necessary for identification of services. Labels are not required on stop cocks to branch outlet points.

Valve labels shall be of rigid plastic with engraved or stamped lettering filled in with an approved composition to provide a clear and permanent indication of the functions of the valve, switch, control etc. The labels shall be affixed in position by a non-ferrous metal chain.

Each label shall be numbered to agree with a combined pipework schematic and valve schedule; to be prepared by the Contractor in conjunction with the Record Drawings. A light-fast copy of this pipework schematic is to be fitted into a glazed picture frame supplied and fixed in a suitable position by the Contractor.

One such diagram shall be placed in each boiler room and plant room or such other places as stipulated by the Engineer. To avoid confusion amongst those who have to interpret the diagrams, the diagrams shall be limited in scope to shewing only the pipework, valves and items of equipment present within each specific boiler room, plant room or other location.

Materials & Workmanship – Electrical

2.25 General

All materials used in connection with work covered by this Specification shall be new and obtained from approved manufacturers. Preferred or approved manufacturers are given in this Specification and, unless otherwise stated, Contractors will be required to supply materials of a type and manufacture as indicated.

Where the Contractor is instructed to employ materials supplied through other Contractors, or from other sources, or is instructed to re-use existing material supplied by the Trust he will be responsible for satisfying himself that the material is in good working order, is suitable for the use intended and for notifying the Engineer if, in his opinion, the material is unsuitable for reasonable application, in accordance with his instruction. The decision of the Engineer shall however be accepted as final.

The Contractor shall not disconnect or otherwise interfere with any part of any existing electrical installation or carry out any alterations or additions to any part of any existing installation without first obtaining the approval of the Engineer.

All work shall be carried out in such a manner as to ensure the installation and its associated apparatus will not be impaired or damaged due to the presence of other services in the vicinity special attention shall be paid in situations where there is any possibility of delayed damage to the installation arising from the proximity of hot pipes or apparatus, the presence of vapours or liquids or the existence of any conditions which is outside the performance limits of the materials employed.

2.26 Regulations

All work shall be carried out in accordance with the requirements of this Specification and in conformity and compliance with the IEE Wiring Regulations - 16th Edition (with latest amendments) and all relevant British Standards and Codes of Practice.

2.27 Conduit and Conduit Fittings

General All conduits, plastic and steel, shall be installed with a continuous circuit protective conductor throughout, and are to be fully re-wireable. No conduit smaller than 20mm diameter shall be used on any part of the installation which is energised at mains voltage, except where otherwise specified. Conduits shall be of sufficiently large section and so arranged with draw-in or inspection boxes to permit the easy drawing-in or removal of one or all of all of the cables in the conduit.

The number of cables in any conduit shall not exceed that laid down in the current edition of the IEE Regulations.

No more than two right-angled bends or four 45 degrees set shall be installed between draw-in or inspection boxes. The maximum length of conduit between draw-in points shall not exceed 6 metres. The Contractor shall ensure that no draw-boxes, conduit boxes etc, are enclosed or otherwise rendered inaccessible by the activities of other trades.

Surface, or buried conduits shall be run symmetrically and parallel to the building lines with easy sets or bends at angles. Where multiple runs change direction, the radii of bends shall be laid from a common centre, and where draw-in points are required at right-angle changes of direction in multiple runs, adaptable boxes shall be used.

All conduit runs shall be agreed by the Engineer to his representative on site before commencement of work. The conduit system shall be carefully planned to avoid all unnecessary bends, sets or changes of direction.

Conduits entering equipment and trunking shall be terminated with adapters and a male screwed

bush.

Conduits shall be checked for rigidity and mechanical change before plastering or concealing within the building fabric, and before cables are drawn in. In addition, installations comprising steel conduit shall also be checked for satisfactory electrical continuity before burying.

Conduits may not be chased into any wall in a manner likely to affect the structural integrity. Nor shall they be installed in anti - static floors unless precautions are taken to preserve the integrity of the anti - static properties of the floor.

All conduit boxes used as outlets or draw-in points shall be of the standard circular pattern. Elbows, tees and inspection bends will not be permitted. Rectangular boxes shall be used for sizes above 32mm or for cables 4 □mm cross-section and above.

Outlet boxes shall be provided at all outlet points unless otherwise specified.

Conduits shall have a minimum clearance of 100mm from any heating or hot water pipe. Care shall be taken to prevent foreign matter entering the conduit system during installation; caps or plugs shall be used to protect open ends.

After completion of the conduit works, the installation shall be inspected and approved before any cables are installed. The Engineer reserves the right to reject any part of the conduit installation if, because of flattened bends, incorrect pipe setting, untidy layout unsymmetrical arrangement of switch and/or fuse gear or other evidence of bad workmanship, the general appearance of the installation is untidy or haphazard.

Flexible conduit connections to equipment shall be at least 450mm long terminating with conduit adapter or adaptable box enclosing sufficient slack cable to enable "Tong Test" readings to be taken on each conductor. Earth continuity shall be maintained by a stranded conductor installed within the flexible conduit.

The installations shall be self - draining with adequate drainage points at its lowest levels.

Plastic: Plastic conduits shall be LSF to BS 4607 and BSEN 50086 as applicable. It shall be heavy gauge high impact, smooth inside and outside, free from imperfections and no smaller the 20mm.

Install in accordance with the manufacturers instructions, using all necessary fittings and accessories. Ream to remove all sharp edges and burrs, and clean off all debris.

Saddles shall be fixed at spacings not exceeding the following:

Conduit Size	Vertical & Horizontal Spacing
20 - 25mm	1.2m
32 - 40mm	1.5m
50mm	1.8m

Additions, saddles shall be fixed with 150mm of all bends or sets.

Plastic conduits shall not be installed where the ambient temperature is below -5°C or the working temperature is above 60°C.

Plastic conduit boxes shall not have self tapping screws or push - in threaded inserts for the suspension of luminaires.

Internally plastic conduits shall be white finish **externally** they shall be black.

All jointing shall be carried out using PVC solvent as recommended by the conduit manufacturer. Adapter boxes shall be of high impact PVC with covers of the same material secured by a round head screw at each corner. The internal depth of the box shall not be less than 40mm. All inspection and draw-in boxes shall be provided with covers secured by round head screws.

Steel: Steel conduits shall be to BS4568 and BSEB50086 for sizes up to 32mm or to BS 31 for sizes above 32mm.

Conduits shall be steam welded, heavy gauge screwed, finish Class 2 for dry non - corrosive

situations; seam welded, heavy gauge, screwed, finish Class 4 for flameproof, external and damp situations or where specified in Section 3.

Thread to the correct length, ream at both ends to remove all sharp edges and burrs after screwing. Galvanized conduits shall be installed with all necessary galvanized accessories, fixed with sheradized or galvanized screws. Paint to the requirements of BS5493 where threads are exposed. Conduits are to be left clean and free from oil and shall be thoroughly swabbed out after fixing and immediately prior to the drawing in of cables. No conduit bearing traces of damage or rust shall be used.

The conduit is to be laid as far as possible in straight lines. Where conduit is to be bent, it must be bent cold without altering its section with an approved type bending block, to give results consistent with the best grade of craftsmanship.

Where conduit is run on the surfaces of walls, ceilings or in false ceilings, it must be properly and neatly fastened at intervals not exceeding 1220mm for 20mm and 25mm sizes, and 1800mm for sizes 32mm and over. All fixings shall be made by means of spacer bar saddles and conduit shall be fixed with a saddle not more than 150mm from each surface box, bend or set.

The conduit installation is to be rigid throughout and this shall also apply to conduit in the floor screeds.

The conduit installation is in no part to be under mechanical stress and shall be mechanically and electrically continuous throughout.

2.28 Fixings

The Contractor shall include for the supply and fixing of all necessary brackets, plugs and bolts for steelwork, walls, ceilings etc., where required to securely fasten conduits, cables, cables tray, trunking, saddles, switch and socket outlet boxes, distribution boards and other fitments in position.

2.29 Cable Trunking

General Trunking shall be installed in accordance with the manufacturer's written instructions and shall be complete with all accessories, including bends, tees, flanges, sleeves, end caps, reducers and barriers, together with cable retaining clips fitted at 2ft (600mm) intervals.

All trunking routes shall be approved before commencement of installation.

All cable trunking risers shall be installed truly vertical with all other trunking runs installed truly horizontal.

Where connection is made between trunking and a distribution unit the cable entries shall be sized to accept cables for all used and spare ways.

Individual trunking sections shall be independently supported. On straight runs, fixings shall be at regular intervals not exceeding 900mm with steel dome head fixing screws. Unless direct fixing is a definite requirement, trunking shall be secured to the building fabric and spaced off the structure to a minimum distance of ¼" (6mm) by means of steel spacers. Spans of trunking will only be permitted where the design is adequate for the particular requirements.

Where trunking containing more than one compartment is specified, the correct arrangement of crossover sections shall be employed where necessary, in order that power and low voltage cables are properly segregated along the entire length of the trunking.

Cable retaining straps shall be fitted at intervals not exceeding 2ft (600mm) when trunking is installed with its covers in the side or underside. Alternatively, trunking manufactured with one edge formed as a retaining trough may be substituted, but this design may only be used where the lid of the trunking is fitted on the side.

Vertical runs of steel trunking, exceeding 10ft (3m) in length shall be fitted with insulated pin racks to support the cables. Insulated cable support pins shall be fitted at intervals of 4ft (1.2m) in vertical runs of plastic that exceed 6ft (1.8m) in length. The first pin in cases where junctions

occur, shall not be more than 12" (300mm) from such junctions.

Trunking shall be fitted with overlapping cover plates when installed flush with the building fabric. The edge of the trunking to be flush with the finished surface of the building fabric.

Provide a separate insulated circuit protective conductor (cpc) within the trunking to maintain earth continuity, irrespective if the trunking is made from steel.

Plastic Trunking Plastic trunking shall be LSF in accordance with BS 4678 Part IV extruded uPVC, of the high impact resisting heavy gauge type and fitted with drip proof lids.

It shall be smooth inside and outside and free from imperfections.

Separate fixed sections of trunking shall be used where accessories are fitted into it, unless specified otherwise.

Plastic trunking shall be secured to the building structure 2" (50mm) each side of all joints and elsewhere in accordance with the IEE Wiring Regulations.

Cut the trunking to permit conduits direct access to the appropriate sections where conduits are connected to multi - compartment trunking..

Plastic trunking shall not pass through fire compartment walls. Nor shall it be installed where the ambient temperature is below -5°C or working temperature is above 60°C.

Unless otherwise specified in the drawings the colour of the system is white.

Steel Trunking Shall be manufactured from sheet steel (including lids), must be proofed and painted in accordance with BS4678, with finish Class 2 for dry non-corrosive situations and finish Class 3 for external and damp situations.

Standard flanged couplings shall be used to terminate trunking at apparatus, at adaptable boxes and at points where it is desired to connect one section of trunking to another where a standard fitting is obviously unwarranted. The practice of cutting and bending the material of the trunking to form flange attachments will not be acceptable.

Connections between trunking and apparatus shall be by a screwed coupler and bush, or a standard flanged coupling or an adapter neck, fabricated or cast. Direct attachment of trunking to apparatus will only be permitted if cable entries are provided with smooth bore bushes or grommets and the return edge of the lid of the trunking is left intact.

Trunking shall be electrically and mechanically continuous throughout and equipped with tinned copper links at each joint to ensure earth continuity. All links are to be visible, surfaces are to be free of paint at all earth connections.

Trunking shall not contain any sharp edges or projections likely to cause abrasion or damage to cables, and manufactured with inward return edge flanges. It shall be painted to the requirements of BS5493 immediately when bare metal is exposed - save where needed for earthing connections. Provide a proprietary method of traversing structural expansion joints in accordance with IEE Regulations.

Except where otherwise specified or where proprietary brands of lighting trunking are designed with plastic covers, all trunking covers shall be in metal finish to match the trunking. Covers shall be stiffened by flanging down each side of the trunking or by folded edges designed to mate with the recesses formed in the trunking or by drip -proof close fitting covers. When used as floor trunking, it shall be provided with lids, which accommodate the floor finish. It shall be fitted with fixed section lids where accessories are mounted on the trunking. Fixed section lids shall also be used where trunking passed through the structure. Such fixed sections are to be restricted to the minimum length necessary. Sections with fixed covers shall also be used through, and extending 12" (300mm) either side of fire barriers. They are to be externally and internally sealed as per IEE Wiring Regulations, over the same distance. Fixing of covers shall be by means of captive large-headed screws or coin operated catches. Loose screw fixings should be avoided. A minimum of 2 fixings shall be provided not more than 6" (150mm) from the end of each length of lid.

Steel trunking shall be drilled to allow conduit access directly to the appropriate section where

conduits are connected directly to multi - compartment trunking. Holes shall not be oversized or eccentric and shall only enter fixed sections of trunking.

Multi - compartment trunking shall be provided with earthed steel partitions to provide the required number of compartments to segregate the services.

2.30 Switchgear and Distribution Boards

Low voltage switchgear shall be in accordance to BS EN 6039 and adequate for the voltage, load current, prospective fault levels, and type of supply, will be as Specified later.

Enclosures shall be of metal construction with all electrical conductors, contacts etc, totally enclosed. They shall be of unit or cubicle construction as specified in Section 7.

Protection shall be not less than IP31 for indoor use, and weatherproof (IP54) for external use and plant or boiler rooms or elsewhere as require in Section 7.

Facilities shall be provided for padlocking to prevent unauthorized interference. The locks to be operable by a key common to all enclosures, switchgear and distributors gear locks.

Provide adequate local access of isolation, earthing and insulation to ensure the safety of operatives conducting maintenance work. Such isolators to be lockable in the OPEN position.

Enclosures are to be adequately ventilated or cooled. Floor mounted panels shall be mounted on a plinth in wet plant areas.

Switchgear is to be finished in manufacturer's standard stoved enamel finish. Plain steelwork to be painted to BS 6150 with red lead primer and two coats of enamel to match switchgear. Dispose so that all operating handles, control knobs, push buttons etc, are within the range of 18" (450mm) and 6ft (1800mm) above floor level.

Switchgear must be so designed and constructed that it provides effective segregation between incoming circuits/busbars/outgoing circuits/control circuits and equipment. Where equipment is fitted above busbar chambers, it shall be impossible for objects to fall into the chamber. The segregation provided shall prevent the passage of ionized gas, resulting from the making or breaking of any circuit under normal or fault conditions, to any busbar, adjacent switch etc.

Enclosures shall be provided with cable entry locations (top, bottom etc) to suit the detail of the scheme and be of adequate size to accommodate all incoming or outgoing cables. They shall be so designed and constructed that all user adjustments are acceptable without opening doors or removing panels - i.e. from the outside.

Switchgear shall not be located such that it could be affected by the normal operation, maintenance or failure of mechanical services installations, including drainage.

Fuse Switches and Switch Fuses shall be to BS EN 60947-3 and fitted with HRC fuses to all line conductors and fitted as required with a neutral link. For units exceeding 100A this terminal shall have a removable bolted link. Facilities shall be incorporated for padlocking to prevent unauthorized interference.

Air Circuit Breakers (ACBs) and Moulded Case Circuit Breakers (MCCBs) shall be to BS EN 62947-2 and provided with positive means for preventing any one pole of a multi - pole MCCB being operated or tripped, independently of the other poles. Facilities shall be provided for padlocking to prevent unauthorized interference.

Miniature Circuit Breakers shall be to BS EN 60898 and provided with single phase or three phase installations magnetic tripping as specified in Section 7. They shall be provided with positive means for preventing any one pole of a multi - pole MCB being operated or tripped independently of other poles. Where located other than in an enclosure, provide facilities for locking to prevent unauthorized interference. Where located within an enclosure, have facilities for locking that enclosure to prevent unauthorized interference. Residual Current Devices (RCCDs) shall be to BSEN 61008 and disposed as required by the Wiring Regulations e.g. to feed caravan installations, to feed apparatus outside the equipotential zone or where specified in

Section 7.

Distribution Boards shall be to BS EN 5486 and fitted with neutral bars having a separate terminal for each outgoing TP&N circuit when required for three phase circuits. For SP&N power and lighting circuits the neutral bar shall be provided with a separate terminal for each outgoing single phase circuit. Distribution boards shall be provided with a separate earth bar for the connexions of circuit protective conductors and fitted with HRC cartridge fuses or MCBs as specified in Section 3. They shall be flush or surface mounted over suitably sized adaptable boxes where surfaces distributions boards are used on recessed installations. Access apertures cut in the back of the fuseboard to be adequately bushed and the box provided with spare conduits all effectively bonded to the board.

Where located in other than within switchrooms, distribution boards are to be provided with barrel type locks. These locks to be operable by a common key or fitted with other means of locking so as to prevent unauthorized interference

Distribution boards shall be fitted with indicators, push buttons, annunciation and digital readouts concurring to the conventions of BS EN 60073, unless specified otherwise in Section 7.

Fuses shall be to BS 88 HRC cartridge type for general lighting and power applications and to BS 136, HRC cartridge type where domestic consumer units are specified. They shall be located within all - insulated carriers incorporating means of identifying failed fuses.

Busbars and Connexions Busbars shall be of constant cross - section copper throughout, and air insulated except where solid insulation is a design feature. The connexions to outgoing switches shall be made using solid copper connecting links - the connexions being as short and direct as possible, insulated cable connexions will only be used on unit type switchboards or where specified in Section 7.

Busbars shall be rigidly clamped and secured to prevent undue movement under fault conditions or displacement as a result of the installation of cabling and provided, where necessary, with insulated phase or circuit barriers. All clamping and supporting bolts, nuts, washers and screws to be plated brass or steel.

Breakers shall be connected by clamps to risers, interconnexions and busbars. Drilled connexions to busbars will only be accepted where specified in Section 3.

Unit Switchboards Unit (industrial style) switchboards shall be to BS EN 60439 - 1 and comprise separate items of switchgear assembled and connected to provide a switchboard served by built in fixings or masonry bolts. It shall be configured for top or bottom entry to suit the application.

The busbar chamber housing shall accommodate the appropriate bars for the system, and the chamber shall be capable of ready extension. The busbar shall be of such length that the outgoing connexions may be taken from the bars at right angles. Undue deviation will not be accepted other than the necessary sets to provide electrical clearance.

Switchboards, in the case of wall mounting units shall be assembled on a steel frame of angle iron or channel sections suitably braced. Floor mounted switchboards shall be assembled above and below a busbar chamber extending the full length of the board, and supported by floor stands below the chamber. Additional support to be provided where required as for wall mounted boards. Switchgear etc, to be supplied with removable gland plates, drilled for conduit entry, or suitable cable glands, clamps, spreader boxes, and reverse entry chambers as required.

Cubicle Switchboards shall be to BS EN 60439 - 1 and manufactured from sheet steel, suitably rust proofed and stove enamelled or equal, finish to the approved colour. Cubicle switchboards shall generally be floor mounting, with access back and front, or front only, as specified in Section 7. They shall be of modular construction with interchangeable units where applicable, and configured for top and bottom entry to suit. They shall be constructed in sections to facilitate

delivery and installation, and, excluding cable boxes, not exceed 7' 4" (2250mm) in height. Provision shall be made within the cubicles for the storage of spare fuses. Switchgear to be supplied with removable gland plates, drilled for conduit entry, or suitable cable glands, clamps and spreader boxes.

Switchgear Earthing Switchboards shall be provided with an earthing terminal consisting of a solid hard drawn copper earth bar, running the length of the switchboard, and bolted to the supporting framework to provide good electrical contact to all sections of the switchboard. The earth bar shall be fitted with a bolted link to permit testing of earth resistance and shall be of the following dimensions:-

Maximum Incomer	Copper Earth Bar
upto 400 A	1" × 3/16" (25mm × 5mm)
upto 600 A	1¼" × ¼" (31.75mm × 6.35mm)
upto 1000 A	2" × ¼" (50.8mm × 6.35mm)

All incoming and outgoing cable armouring glands and earth conductors shall be connected to the earthing terminal by copper circuit protective conductors. Similar connexions are to be provided to the conduit entry plate and to metal trunking.

Connexions, links and lugs shall be secured by brass bolts, nuts, washers and locking arrangements, with the nuts and washers on the front face of the earth bar.

Switchboards shall have any moveable panels carrying items of equipment e.g. push buttons, meters etc./ connected by a flexible circuit protective conductor.

Labels and Identification shall be provided on the front face of all items. The labels shall be of 'Traffolyte' of white background with suitably sized characters (minimum size ¼") coloured red for warning labels and black where used for information. Labels shall be secured by screws to the fixed part of the equipment and not on any withdrawable or interchangeable components.

Provide at each earth terminal bar a label engraved 'Safety Electrical Connexion - Do Not Remove'. Each outgoing switch, for each separate installation, shall bear a label with the following headings, and completed information: _

- Voltage and Phase utilized.....
- Cable size and type.....
- Functions.....
- Reference N°
- Current rating / fuse fitted.....

Provide at each incoming switch fuse as a main isolator for electrical services to an installation or part thereof, a label with the following headings, and completed information:-

- Voltage and Phases utilized.....
- Cable size and type.....
- Functions.....
- Reference N°
- Current rating / fuse or link fitted.....

Switches, isolators, motor starters and all other electrical equipment shall be clearly labelled or engraved, stating functions and supply source reference etc.

Earth tags shall be stamped from non - corrosive metal and fitted at all bonding and connexion points.

At each main distribution point, a schematic diagram shall be fitted giving details of the electrical distribution system of the building. The diagram shall give detail of all conductor sizes and L - N impedance at all points.

Diagrams shall be on transparent plastic with a white plastic sheet backing with wood frames protected with clear rigid PVC sheet.

An Electrical Accident Instruction sheet as per the *Electrical Times* metal copy, shall also be fixed at each of the main distribution points.

A chart or table shall be provided at each final distribution board giving details of the circuit designations, protection, conductor sizes, L - N impedance, Earth Loop impedance etc. The chart shall be in a rigid, clear PVC envelope secured to the inside of the lid of the distributions board or adjacent to it.

2.31 Cables and Wires

All PVC insulated cables shall be Low Smoke and Fire, manufactured in accordance with BS 7211 450/750 volt grade and shall be coloured to comply with IEE Regulations, and from the 'Smoke Master' range as manufactured by BICC Cables Ltd (0181) 3975222.

No conductor shall have less than three strands and shall not be less than 1.5mm² in section. All cables used shall be rated for use at a minimum ambient of 85 degrees C.

The contractor shall be responsible for ensure that single phase circuits in any one area are connected to the same phase in accordance with the instructions contained in the Specification and drawing.

Cables shall be installed from distribution boards to switches and terminal points without any joints or intermediate connexions other than at switches, luminaires or other outlets.

For final sub- circuits serving more than one point, the "looping-in" system shall be employed and not more than three cables shall be bunched at any one terminal.

When making connections the insulation shall be stripped back so far as is necessary to effect proper connection and not more than 2mm of bare conductor shall appear at terminals after connection has been made. All strands of all conductors must be employed when making connections and must pass under and be firmly secured by terminal screws and/or nuts.

The lead and return conductors of each circuit shall in all cases be drawn into the same conduit or trunking.

Cables shall be laid into trunking after the removal of all lids. They shall not be drawn into trunking except where it passes through the structure.

The ends of all cables shall be labelled in a standard manner and in conformity with the identification given in the drawings or instructed by the Engineer (using up to three symbols per cable end). Oval type cable markers shall be used. When cables are installed in trunking ducting of floor ducting, all cables comprising any one circuit shall be bound together and clearly identified at intervals not exceeding 2 meters and at each junction box and floor trap.

Cables shall draw easily into conduits or ducts without chafing or binding. If during the course of the work cables are found to be damaged due to tight drawing or because of burrs or sharp edges in the conduit or trunking system, or for any other reason, the contractor may be instructed to remove part or all of the cables installed up to that time to satisfy the Engineer that they are in good condition. Should such instructions be issued the Contractor shall carry out the work of withdrawing and re-installing such cables as are indicated by the Engineer including the replacement of any cables found to be faulty entirely at his own expense.

Sufficient slack cable must be left at points and switch drops to enable fittings, switches, switch plugs etc to be withdrawn at least 75mm from their conduit boxes without disconnecting cables.

Cables shall not pass through luminaires unless of the heat resistant type. Nor are they to be connected directly to any lamp holder or other appliance where temperatures are likely to exceed the maximum operating temperature for the insulation specified in the appropriate British Standard without the use of high temperature sleeves or heads.

2.32 Flexible Cables and Cords

Flexible cables and cords shall not have conductors smaller than 3/4(mm (24 / .2 mm) unless otherwise specified, and shall be 300/500 volt grade. They are to be of circular construction

possessing colour coded cones in accordance with the IEE Wiring Regulations.

Cables are to be BASEC approved and ethyl propylene rubber insulated chloro-sulphinated polyethylene sheathed white for general appliances and temperature upto 85°C. They shall be of the heat resistant type of silicon rubber PTFE glass braided for connexions to luminaires. Heat resistant insulated connectors to be used under these circumstances.

2.33 Mineral Insulated Cables

Mineral insulated copper sheathed cables shall be heavy duty 750 volt grade and manufactured in accordance with BS 6207.

The cables shall consist of solid drawn copper sheath housing high conductivity copper conductors of the required number and sectional area, embedded in pure and highly compressed magnesium oxide insulation serviced overall with a white coloured seamless PVC sheath.

The size of cable shall be determined in accordance with the current rating and the maximum allowable voltage drop as set out in the current edition of the IEE Regulations.

All cable terminations shall be complete with a white PVC shroud and appropriate size gland and shall be made with screw-on pot type seals using cold plastic compound and neoprene or PVC sleeving all of an approved pattern, and applied in the same manner and by the use of appropriate tools, recommended by the manufacturer.

Cables are to be sealed immediately on being cut to length, if necessary temporarily. before final sealing, precautions shall be taken to expel any moisture from the insulation.

All fixings shall be by means of copper clips or saddles, PVC coated where used with PVC served cables. Clips or saddles shall be placed not more than 75mm from either side of a fitting, accessory or right angle bend and not more than 300mm apart elsewhere.

2.34 Cables PVC/SWA/PVC and Cross Linked Polyethylene (XLPE/SWA/PVC)

PVC/SWA/PVC cables shall be BASEC approved to BS 6346 600/1000 volt grade possessing copper conductors armoured with a galvanised steel wire armouring.

XLPE/SWA/PVC cables shall be BASEC approved, to BS 5467 600/1000V grade possessing copper conductors with galvanized steel wire armouring.

Unless specified otherwise LSF grade cables shall be used internally.

The Contractor shall determine the lengths of cable required and place orders as necessary. Any length found to be measured short, shall be replaced by another cable of the correct length.

Cable ends must be sealed until terminations are carried out, and the Contractor must exercise the utmost care with cables in the storing, running off, drawing into ducts, bending and other processes involved to ensure that damage to the cables or any part of their makeup is prevented. Care shall be taken and sufficient labour and equipment provided, to ensure cables are installed without damage to cable, or its contents.

Cable sweeps and bends shall be within the permitted radius allowance of the cable manufacturer and the Wiring Regulations. Minimum cable bending radii shall not be compromised - particularly during installation.

Cables shall be installed only when both the cable and the ambient temperatures are above 5 degrees C and have been so for the previous 24 hours, or when special precautions have been taken to maintain the cable above this temperature.

The Contractor shall supply to the Engineer two copies of the manufacturer's test certificate for all cables.

Joints will not be permitted in any single drum length of cable.

Steel wired armoured cables shall be made off using brass compression glands with screwed male electric threads for fixing to switch gear etc, and shall comply with BS6121. Suitable seals shall be incorporated to provide a moisture proof seal between the bush and the outer serving and the bush and the inner sheath. Glands shall have core grip armour clamps with suitable provision for

cross - joint bonding. A gland earthing ring shall be provided with a cable linkage to the earthing terminal for the switchgear or distribution board.

Cable termination shall be affected using compression joints. Lugs or ferrules of sufficient wall thickness shall be crimped onto the stripped conductors. Contractor must ensure that the proposed design has been fully tested and is suitable for the application. The hydraulic pump used must be such that the dies cannot be removed from the joint until the ram has travelled the whole distance of its compression stroke, full pressure attained and the correct crimp depth obtained. All joints shall be wrapped with PVC tape to BS3924, with sufficient depth, to provide a degree of insulation, at least equal to that of the original.

Cable armour shall be firmly clamped to the equipment panel to prevent the weight of the cable being borne by either the gland or the terminals.

Cables shall be provided with additional protection from mechanical damage to a height of 5ft (1½m) above floor level where run vertically in the surface of walls inside the building and outside, or in any other location where the risk of damage is increased.

Cabled entry into a building shall be by means of a short length of PVC or earthenware duct in the form of a slow bend. The entry point shall be sealed to prevent the ingress of gas, heat, flame, moisture and vermin. The sealing agent must have a fire resistance equal to that of the structure.

Surface mounted cables not continuously supported on cable tray shall be secured to building elements using plastic or silicon aluminium claw type cleat supports of the correct type, size and spacing to suit the particular cable.

Each run of cable shall be identified at each end by a secured attached non - corrosive metallic or substantial plastic label, engraved to indicate the cable size and circuit.

2.35 Cable Ducts

Cables to be installed within the floor screed shall be drawn into ducts provided for the purpose and after the cables have been drawn into the ducts the ingress of moisture shall be prevented by sealing each end with approved waterproofing compound.

2.36 Cable Trenches

Trenches shall be of the minimum depth and width, with spacings between services and trench width as below:-

Cable Depths

General Conditions	Traffic Roads	Cultivated Areas	Areas beneath Drainage
500mm	750mm to top of ducts	600mm	1000mm

**Minimum Spacing between Services Laid
Direct in the Ground**

Cable	HV	LV	Communications & Alarm	Gas & Water	Hot Services
LV	300mm	75mm	300mm	600mm	800mm
Communications & Alarm	600mm	300mm	50mm	600mm	800mm

Minimum Width of Cable Trenches for Required Depths

Nominal Depth	Nominal Width
Down to 500mm	300mm
Down to 1000mm	500mm

Provide 100mm diameter ducts one per cable in the case of swa LV cables at road way crossings. The ducts to extend 1m on either side of the roadway and be covered by a haunch of concrete.

Lay cables on a 75mm deep layer of sand and cover cables by another 75mm deep layer of sand, after laying. Back filled with the excavated earth well rammed down. Not more than 150mm depth of soil to be rammed down at one time. Lay one or more continuous strips of plastic marking tape clearly and indelibly marked **DANGER ELECTRIC CABLES** positioned at nominal 300mm above cables.

Where scheduled minimum trench depths cannot be accommodated provide PVC or earthenware ducts set in concrete.

2.37 Cable Trays

Cable trays shall be of the perforated type and galvanised finish, having the minimum dimensions specified below:-

Nominal Width	Minimum Height of Upstand	Nominal Thickness of Steel Sheet
50 - 150mm	12mm	1mm
225mm	12mm	1½mm
300 - 600mm	20mm	1½mm

Support at intervals to provide rigid fixing, and install with a minimum spacing of 2" (50mm) between the structure or any other building component and trays.

Rest tray on purpose made MS supports utilizing steel channels or by means of proprietary hangers, cantilevers or stand - off brackets.

Install using factory formed bends, tees, risers etc. of the same thickness and finish. Fabricated sets shall be free from sharp edges and joined by means of fishplates bolted to each section by mushroom head galvanized steel roofing bolts.

Bond in its entirety by 12mm x 1½mm copper links bolted across each joint by means of M6 brass nuts and bolts complete with flat and spring washers.

Cables shall be secured by means of proprietary forms heavy duty plastic clips or straps or PVC covered copper or brass cable clips, brass saddles or straps. Nylon cable ties or similar will not be acceptable

2.38 Cable Ladder

Cable ladder shall be heavy duty type, fabricated from mild steel at least 2mm thick and galvanized after manufacture. The side rails shall be at least 125mm deep with the rungs sat towards one edge, spaced at regular intervals, approximating to 300mm, and provided with elongated holes to accommodate the cable trays.

Length of ladder shall be coupled, and bonded in a similar manner to that for cable tray. Changes in direction, level and width, shall be achieved by means of standard fittings such as radiussed

risers and gusseted intersections purpose - designed for the system. Cable tray shall be accommodated on the ladders system for cables less than 15mm overall diameter.

2.39 Isolators for Fixed Appliance

The Contractor shall include for the supply and installation of a local isolator for every fixed appliance, whether or not such an isolator is explicitly specified.

Each isolator shall have the rating and number of poles suitable for the particular appliance and shall be of approved type and manufacture, flush or surface mounted as required. All isolators shall be mounted in accessible positions local to the particular appliance which they serve. They shall be generally mounted at a height of 1.4m above finished floor level to the centre line of the switch.

Each isolator shall have an engraved plate of approved pattern, labelled to indicate the unit which it serves.

2.40 Socket Outlets (General Purpose)

General purpose socket outlets shall be provided and installed in the position indicated on the drawings.

They shall be twin switched units and indicated as complying with BS 1363.

Where 13 ampere sockets are installed for a specific appliance, the associated plug shall be fitted with a fuse of the correct rating to suit the appliance concerned.

In those situations where a low level socket is required, they shall be routed at 450mm above finished floor level.

All sockets shall be of specified type and manufacture and shall be complete with plastic or metal mounting box of the same manufacture. All metal mounting boxes shall be complete with earth terminal; plastic boxes shall have earth terminals as necessary.

13 Ampere sockets will generally be installed using ring circuits in accordance with the IEE Regulations.

2.41 Fused Connexion Units

All fused connection units shall comply with BS 367 and be of the same manufacture and finished as the socket outlets.

Plates, switch dollies and screws shall be of specified materials and finish.

Units shall be flush or surface mounted with switch, neon indicator and flex outlets as required complete with metal bore and earthing terminal.

Units shall be fitted with a fuse of the correct rating to suit the appliance concerned.

Flex outlets shall generally be arranged as follows:-

From the particular connector unit a plastic conduit will be run direct to the appliance, if the appliance is fixed and permanent.

If the appliance requires a flexible connection the conduit shall run to a point close to the point of entering the supply into the appliance, there terminating in a conduit box with domed cover and gland outlet suitable for the particular flexible cable or in the case of those phase equipment, having a connection by means of cables housed in "Kopec" or PVC sheathed flexible conduit, running from the conduit box to the machine.

An earthing lead shall be connected to each appliance from a suitable earthing terminal.

In certain cases, where specified, fixed connector units with direct flex outlets may be used.

2.42 Lighting Switches

Lighting switches throughout each area shall be of the same manufacture and finish as the general purpose socket outlets, shall comply with BS 3676 and be capable of carrying the full rate

inductive or resistive load in accordance with the above specification.

Lighting switches shall be of the types and sizes specified and unless otherwise stated wall mounted types shall be fixed at a height of 1.4 metres from the floor to the bottom edge of the box or cover plate. The position of the switches are indicated on the drawings, but the Contractor must ascertain all door hangings and other fixtures before proceeding and care must be taken to see that all doors will swing clear of installed switches. Locate the switches in a convenient logical position for the users.

Where cord operated "Pull" type ceiling switches are specified to be used, they shall be located on the ceiling in such a manner that the cord will hang free a minimum of 75mm from any wall face and also be clear of any door movement. The cords of all ceiling switches shall be of sufficient length (without joints) to reach a point 1.4 metres from floor level unless otherwise specified. The Contractor shall shorten all cords to this level.

Where several switches on one phase are shown at one position, a ganged box shall be used. If several switches on different phases should occur at one position, separate units shall be used.

2.43 Luminaires

Luminaires shall be of the type and size stated in the schedule but the Engineer reserves the right to request a sample of each type of luminaire concerned to be submitted for final approval prior to placing the order for the total quantity.

The luminaires shall be installed in the approved manner and to the mounting height and positions specified. In any instance, when the information is not clear, the Contractor shall obtain a ruling from the Engineer. The Contractor shall include in his tender for all adjustments to suspension tubes, chains, etc., that may be necessary to comply with the specified mounting heights. Due note shall be taken of ceiling void depths and suspensions shall be allowed for accordingly.

All luminaires shall be thoroughly cleaned prior to erection and finally wiped when in position to remove all finger marks etc.

Fluorescent lighting fittings shall not be fixed to or suspended from conduit boxes, but fixed directly to or suspended from the ceiling with a flexibly cord connecting the fluorescent light fitting to a ceiling rose mounted on a conduit outlet box. In the case of fluorescent lights fixed to suspended ceilings, the cord shall be passed through the ceiling tile to a ceiling rose mounted on a conduit outlet box within the ceiling void.

All "discharge" luminaire units shall be provided with a capacitor for the purpose of power factor correction to a value in excess of 0.85 lagging. It is the Contractor's responsibility to check with the manufacturer that the noise level of the luminaire is suitable for the particular location before placing an order. In case of doubt reference should be made to the Engineer. The Contractor shall bear the cost of replacing luminaires considered by the Engineer to be too noisy for the particular location.

Breakjoint rings or "Biscuit" rings of approved colour shall be provided for all suspended luminaires and fluorescent batten luminaires of the slim type where the batten is of insufficient width to completely cover the conduit box and its associated clearance hole in the ceiling.

Luminaires mounted on suspended ceilings shall be connected by 3 core heat resisting PVC insulated and sheathed flexible cords, $\frac{3}{4}$ mm cross-sectional area complying with BS 6141 and terminating at their upper end in a MK 3-pin plug (K3230 WHI) which locate in an MK circular socket (K3220 WHI) mounted on a conduit box fully accessible within the suspended ceiling void immediately adjacent the luminaire. Where appropriate substitute the 4-pin plug and associated socket (K4230 WHI, K4230 RED, (emergency) K4220 WHI).

All luminaires shall be supplied and installed as indicated on the drawings complete with control gear etc to make them functioning units and lamps of specified type and wattage.

2.44 Lamp Holders

Lamp holders for use with tungsten element lamps shall be bayonet capped type for up to and including 100 watts, and Edison screw type for 150 watt and above.

Shade carrier rings shall be provided except where the lampholder is part of an enclosed fitting.

All insulated lamp holders shall be complete with Home Office pattern skirts.

Lamp holders for use with flexible cord shall be all insulated cord grip pattern with solid stem plungers having external springs. The cable entry for sheathed cords shall be large enough to allow the sheath to enter the lamp holder.

Lamp holders incorporated in weatherproof fittings shall be porcelain.

2.45 Extract Fan

Manually controlled, extract fan shall be supplied and installed by the Contractor in the positions shown on the drawings and of the type described in this specification.

The fan shall be fed from a switched isolator complete with fan symbol surface mounted. Fixed connection to fan shall be via a heat resisting flexible cable.

2.46 Earthing Arrangements and Protective Conductors

There shall be in accordance with the IEE Wiring Regulations, and shall comprize separate neutral and protective conductors throughout.

Provide for the main equipotential bonding conductors to connect to the main earthing terminal, all incoming main metallic piped services, and to lighting protections systems, if fitted. The metallic sheath of telecommunications systems to be similarly bonded only with the permission of the operator. The extraneous conductive parts of all other separate metallic services particular to the building are also to be connected to the main earthing terminal; including central heating, air conditioning / ventilation, gases and compressed air and vacuum systems and the exposed metallic parts of the building fabric.

Where necessary, include for the extraneous conductive parts of exposed metalwork to be connected to circuit protective earth conductors by supplementary bonding conductors to maintain an equipotential zone.

Earth Systems At each main supply position, fitted with earthing as specified in the switchgear clause, provide an earthing conductor connecting the switchboard to either or both of:-

(a) a main earthing terminal provided by others.

(b) the main earthing bar associated with the earth electrode system.

Where copper strip is run in the building structure, it shall be fixed by purpose made brass or bronze saddles, and have brass bolts, nuts and washers for all fixings - bronze where liable to corrosion. Where the copper strip would be liable to corrosion (buried in ground, floors, walls, fixed externally etc.) it shall be PVC sheathed or wrapped with corrosion resistant tape.

Protective Conductors The cross-sectional area of every protective conductor, other than an equipotential bonding conductor or a protective conductive specifically specified in Section 3, shall be sized by selection or by calculation in accordance with the IEE Wiring Regulations. However, if the overcurrent device, in addition to providing protection against indirect contact is providing only short circuit protection but not overload protection, the adiabatic equation must be used if the earth fault current is expected to be less than the short circuit current. This requirement applies even if the protective conductor cross - section area does comply with Table 54G of the Wiring Regulations.

As the continuity of cable gland joints to switchgear enclosures is notoriously unreliable, and notwithstanding the pressure of an earth tag washer and cable linkage, each wire armoured cable shall be provided with a separate circuit protective conductor.

This cpc shall be sized on the basis that it alone is providing the protection and on the assumption, that no contribution is made by the armouring.

2.47 Inspection and Testing

The whole of the installation shall be inspected in an orderly sequence to ensure that the requirements of the specifications, the IEE Wiring Regulations, the Electricity at Work Regulations and British Standards are met. The tests will be carried out using instruments of the type and standard specified.

Inspection and Tests The procedure shall include a visual inspection of the installation including equipment, subways, shafts, ducts, walkways, crawlways and false ceilings where accessible together with the items as described in the IEE Wiring Regulations. It shall also encompass the operations of all accessories and all items of fixed equipment. These tests are to be conducted under conditions of normal operations and the results noted.

Method of test The procedure shall include:- the testing of all equipment in accordance with the Wiring Regulations, the operations of equipment by properly trained and competent persons and witnesses in accordance with Section 3.

It shall encompass disconnections, or similar operations as are required to fully satisfy the test requirements and re-connections to restore the installations.

Simulate fault conditions in the 'normal' electricity supply system to ensure that the emergency supply changeover contactors sensing circuits, phase failure relays, timers etc., operate correctly and, reset correctly so permitting the subsequent re-setting of the installations to the correct operating condition.

Insulation tests shall be made on all armoured cables of 25(mm and above with lengths exceeding 16ft (5m). These tests shall be made with isolators and switches in the open position and under competent supervision to ensure the safety of persons and prevention of damage. The Contractor will be required to rectify any faults, or replace any part of the installation which fails or breaks down, as a result of the insulation tests.

Tests on the wiring/cablings for such services as fire alarms, communication, alarms, TV and radio etc. shall be made before the terminal equipment has been connected but with the cable terminations completed, so as to preclude either damage to the terminal equipment or false test results.

Record and complete all schedules, tests, inspections and completion certificates, with copies in accordance with the Wiring Regulations.

In the event of unsatisfactory tests, a witnessed repeat test will shall be performed, after rectifications of the fault(s).

Test Equipment shall be correctly calibrated and certified for the limits of accuracy necessary, and identified by serial number of each test sheet. If an instrument used is considered suspect, it shall be tested by an authorized standard testing laboratory. All equipment shall meet the requirements of BS EN 61557 to ensure the safety of the operator, and be of the following types for the associated functions:-

ring final circuit continuity	low reading ohmmeter capable of reading fractions of an ohm to a high degree of accuracy
protective conductors continuity	heavy current low reading ohmmeter capable of reading fractions of an ohm
earth electrode resistance	hand driven alternating current generator with a minimum voltage of 240V and a maximum current flow of 25A.
insulation resistance	hand driven generator 500 vdc
polarity	<i>Avometer</i> or other approved commercial

	instrument
earth fault loop impedance	phase/earth fault loop tester * neutral/earth fault loop tester*
residual current devices	test net comprising transformer with two separate windings at 240V primary and 45V secondary, with core earthed to primary circuit protective conductor.

*These instruments must indicate the impedance value directly in ohms with means of measuring and correcting for voltage variations. Instruments of the 'pass / fail' type will be unacceptable.

Additional miscellaneous requirements to be verified during the installation. The whole of the work shall be continuously checked throughout the installation period to ensure complete safety and compliance with the specification.

Switchgear shall be checked for correct labelling, complete circuit schedules and satisfactory operations. Interlocking and isolation facilities shall also be checked, including the ability to lock off.

Clearances around switchgear for operations and maintenance will also be confirmed for adequacy.

Distribution board labels and records shall be inspected for correctness and completion. Fuse ratings to be verified against unit schedules and specifications. MCB boards to be checked for satisfactory operation by hand.

The radius of all cable bends will be established as shall the provision of mechanical protection and cable shrouds.

The protection of live parts to IP2X, the presence of test facilities and the location of user adjustments shall be confirmed.

Cable trenches will be inspected for dimensions and spacings between services, the provision of ducts, identification tapes, sand bedding etc.

All switching and control arrangements will be checked against drawings and for operations also, the labelling and engraving will be inspected for compliance with drawings and specification.

Luminaires will be inspected for operations, and correct colour and rating of lamps.

Socket outlets and connexion units will be checked to confirm:-

- compatibility with specifications and drawings
- labelling and engraving is in accordance with specification and drawings

Three phase power outlets shall be checked to ensure:-

- provision is in accordance with the specifications and drawings
- labelling and engraving is in accordance with the specifications and drawings

Section N° 3

General Conditions

3.1 Drawings

The following tender drawings, accompanying this Specification shall be taken as forming a part thereof:-

14 – 821	Proposed Ventilation Installation – Layout I
14 – 822	Proposed Ventilation Installation – Layout II

3.2 Scope of the Works

The work encompasses the provision of a supply and extract ventilation system to serve the new hall.

The contractor will be required to provide the mechanical and electrical services, the builder's work, and all other works relating to this contract. He will be required to provide all necessary builder's work details and wiring diagrams to enable the other trades to carry out the relevant works. He will also be required to liaise with his sub-contractors both to agree a suitable installation programme for the works, as well as ensuring its maintenance.

It is anticipated occupation of the site by the contractor will commence during late summer 2014.

3.3 Tender Basis

Tenders shall be submitted on a fixed price basis, with any fluctuations in the cost of materials and/or labour will be deemed to be included.

The defects liability period shall be twelve months.

3.4 Order of Works

Normal working hours for the site is 8-30am to 5-00pm Monday to Friday, but the contractor may if he wishes, and with the agreement of Mr Desmond George (01654) 767251 and (07977) 943249, work at weekends and outside of the normal working hours.

To avoid interfering or disturbing hall users it may be necessary for some of the works, principally all noisy operations (*e.g.* drilling, chasing of masonry), service interruptions and changeovers to be performed out of hours.

Any extra costs, which the Contractor might incur to comply with these requirements, shall be fully allowed for in his tender sum – no additional payments will be made for out of hours working.

3.5 Occupation of the Building

The Contractor is reminded that he will be required to work closely with the occupants of the building, which will remain in operation while the work proceeds – initial contact regarding site visit etc - Mr Desmond George.

3.6 Interruptions in the Mains Voltage Electrical Supplies

The Contractor must carefully plan his work, phasing it as necessary, so that any shut down in the electrical supply which he requires is confined to those periods which have been agreed beforehand with Mr Desmond George.

3.7 Method of Working

The successful Tenderer will be acting as a main contractor on this project and you should be

fully aware of the implications of the CDM and HASAW Regulations as they apply to your company, those you are responsible for, and others engaged on this project.

Under these Regulations there is a requirement for the principle contractor to prepare a Method Statement for each particular section of the work which has been identified during the design process as possibly hazardous. Enclosed below, is the recognised format which will be required to form an acceptable response to this requirement. This will enable you to generate the construction phase Health and Safety Plan for which as principle contractor you are responsible, to monitor the work and assess implications for everyone present on site.

Method Statements

Format for response by the Principle Contractor

Generic Headings

- *The process (The task or work to be carried out)*
- *Personnel involved (Who will carry out the work)*
- *Equipment involved (Specialist lifting gear, working platforms, etc. required)*
- *Safety requirements (PPE, signage, harnesses, banksmen)*
- *Method of operation (How the work will be carried out)*
- *Training requirements (Specialist equipment handling, use and safety)*
- *Compliance with specific site or client rules*
- *Compliance with Statutory Requirements. (CDM, HASAW, Asbestos Regulations etc.)*
- *Hazard identification and Risk Assessment procedures (Any remaining or consequential hazards identified and assessed)*
- *Disposal requirements and Waste Management (Scrap, hazardous wastes etc.)*
- *Monitoring systems (Review of work procedures and personnel)*
- *Evaluation and review procedures (Was the work carried out in accordance with the original Method Statement, was it practical; any improvements for future similar tasks or work)*

For your information:-

- *The method Statement is an integral part of the criteria necessary to ensure a safe system of work.*
- *It is the link between the Safety Policy, Risk Assessment and Engineering Design.*
- *It should be written in clear, precise language.*
- *It is only applicable to the job, operation or contract as specified. It must not be applied to any other job, operation or contract.*
- *It is a legal authoritative statement describing how the job, operation or contract will be undertaken.*
- *Variations in technique, method or procedures can only be enacted following the issue of a new or amended Method Statement.*
- *The workmen must be made aware of the procedures to be followed in carrying out the work item and their compliance must be monitored by the foreman or contracts manager.*
- *Workmen should sign a copy of the Method Statement to signify their understanding and compliance.*

The following hazards have been identified by the Designer in the Health and Safety plan in relation to this installation.

- (a) *Hazards within the responsibility of each competent tradesman expected during the normal course of the works with solvents, welding, soldering and the use of power tools, scaffolding and towers in a typical construction environment together with the need to issue and wear protective clothing an equipment.*

-
- (b) *Hazards within the confines of the Control of Asbestos Regulations. The contractor should be aware that Asbestos may be present in older buildings and those refurbished between 1950 and 1985. If a material is suspected to contain Asbestos, the contractor is to inform the Contract Administrator before proceeding with the work.*
 - (c) *Working in proximity to electrical services*
 - (d) *Working at heights within rooms*

The Contract Administrator must be satisfied that all of the workmen on site are competent to carry out the tendered work. It will therefore be a requirement that for each project, a simple CV must be provided for each workman before they start on site indicating ACOP and other current qualifications and certificates they hold (with copies) e.g; welding certificates, CORGI registration, pressure systems training etc. You should also pass this requirement on to all or any sub-contractors working directly for you such as insulation contractor, commissioning engineers etc.

A copy of your company's Health and Safety Policy shall be provided for each project, reflecting current concerns over construction project health and safety and the levels and frequency of training given to workmen, particularly over the use and maintenance of all specialist and personal protective equipment. Company employees should be made fully aware of their responsibilities and benefits under this policy.

The principle contractor is responsible for Health and Safety on each site but it is the sub-contractor's responsibility upon commencement on site, to request some form of induction where the principle contractor explains his Health and Safety Plan for the site, any restrictions on working, and health and welfare facilities available for the workmen. The principle contractor must, at all times, be made aware of everyone who is working on his site in case evacuation is required.

3.8 Asbestos

The Contractor is advised that currently it is believed there are no asbestos containing materials present in the area work.

If during the course of these Works, he should discover any material which he suspects may contain asbestos, he shall advise the Engineer as quickly as possible.

If he requires further information he may consult the Asbestos Register.

3.9 Record Drawings

During the progress for the works, the Contractor shall record on drawings in an approved manner, details and routes of all cables. These drawings shall also indicate the position of all sensors, luminaires, control and repeater panels etc, together with identification numbers. Within the period of one month of the completion of the work the Contractor shall supply the Engineer with three sets of *as installed* paper prints. The drawings are to be marked as 'Record Drawings' or 'As Fitted' in large letters near the title block. They shall be to scale - the scales being not less than those of the Contract Drawings.

A complete set of these record drawings will be provided on 'disk' in AutoCAD format - version to be agreed.

3.10 The Building Manual

The Building Manual and the Operating and Maintenance Manuals are to be contained A4 size, plastic in covered, loose leaf, four ring binders with hard covers, indexed, divided and appropriately cover titled. Selected drawings larger than A4, are to be folded and accommodated in the binders so that they may be unfolded without being detached from the rings.

3.11 Operating and Maintenance Manuals

The Contractor shall provide three sets of Operating and Maintenance Manuals one of which shall be incorporated in the Building Manual (Part 3 - Building Services Information) and shall be specific to this project.

The manuals must include:-

- *A complete set of record drawings and wiring diagrams presented in a manner which will be easily understood by the Client's staff.*
- *A full description of each of the mechanical and electrical systems installed, written such that the Client's staff will readily and fully understand the scope and extent of the facilities provided.*
- *Clear descriptions explaining the procedures to be followed when starting up, operating and shutting down all of the equipment and the systems. These descriptions shall include basic Health and Safety practices to be observed whilst operating the plant. They shall also include simple fault finding procedures.*
- *Diagrams of each system indicating principle items of plant, equipment valves, etc complete with key or legends as necessary to render them readily understandable.*
- *The name, address and telephone number of the manufacturer of every item of plant or equipment installed, together with catalogue/model identification numbers.*
- *Manufacturer's technical literature for all items of plant and equipment comprising the project. This information should be the manufacturer's detailed drawings, electrical wiring details and operating/maintenance instructions.*
- *Copies of all test certificates - including, but not limited to, IEE Regulations electrical circuit tests, type tests, works tests, gas soundness tests, pressure tests, start and commissioning flow rates - for the installation as a whole and for the plant, equipment, valves etc which comprise its components.*
- *Copies of all manufacturers' guarantees and warranties.*
- *Details of required maintenance with schedules describing the suggested frequency of action. Include the manufacturer's maintenance instructions, also procedures to be adopted which will ensure the most efficient operation of the installations.*
- *A list of normal consumable items eg filters, fuses, chemicals etc. Also a list of recommended spares to be kept in stock by the Client, comprising those items subject to wear, or deterioration, and/or which may involve the Client in extended deliveries when replacements are required in the future.*
- *Names and telephone numbers of the Contractor's emergency staff.*

Under the CDM regulations and as required by the contract documents, Operating and maintenance instructions are to be completed in draft form before Practical Completion can be achieved.

These Operating and Manuals shall include the information recorded above including instructions on how to carry out simple day to day tasks. They shall be written specifically for this project. All such information shall be clearly and simply presented, in the form of written text and/or flow charts. The method adopted being appropriate for explaining to non-technical personnel the procedures to be followed, when carrying out all of the described operations, with particular emphasis being made on ensuring that these operations will be conducted in a safe manner.

It should be noted by the contractor that the sum of £500 will be deducted from the contract sum if the Operating and Maintenance manuals are not available in draft form at completion of the contract period and the final alterations and submissions to the manual not completed within one

month of Practical Completion. This deduction will not absolve the contractor from completing the manuals and contents.

3.12 Training of Client's Staff

Before practical completion, the Contractor is to explain and demonstrate to the Client's staff the purpose, function and operation of the mechanical installation, including all of the procedures and actions described in the Operating and Maintenance Manuals. This training shall be sufficient to enable them to carry out normal operation of the system as well as simple fault finding.

3.13 Spare Parts

At least two weeks prior to practical completion, submit to the Engineer a list of all of the spare parts, which the Contractor, following consultation with manufacturers, recommends should be obtained and retained by the Client for the maintenance of the installations. Detail for each item, the manufacturer's current price, including packaging and delivery costs to site.

Section N° 4

Ventilation System

4.1 General

This section of the Specification relates to the provision of the ventilation system to serve the new hall.

4.2 Extent of the Work

The work associated with this section comprises:-

The supply and installation of an air handling unit located on the flat roof between the new and the original buildings.

The installation of new supply and extract ductwork from the AHU with individual supply and extract points in the hall.

The incorporation of all necessary attenuators, filters, dampers, controls and interlocks for the ventilation system to function in the manner intended.

4.3 Description of the Works

With the AHU in location on the roof fit a new supply ductwork 350mm wide x 300mm high onto the fan discharge opening of the unit via flexible joint, transformation piece and attenuator. After entering the building via the plant room, transform the duct to 400mm x 250mm and arrange for it to drop to the workshop area on the ground floor. Provide 2 off side branches each nominally 425mm x 125mm and direct these through the end wall as high as possible above the floor but below the horizontal run of dado trunking and to permit the fitting of the supply diffusers.

Arrange for the vertical drop to incorporate a slight double set to clear the electrical trunking before extending as 250mm x 250mm duct to enter the right hand access opening to the void under the floor. Immediately on entering the void space transform to 300mm x 200mm and introduce a double set before directing the duct to run as high as possible the length of the void. At the far end arrange for the duct to enter a plenum chamber 250mm x 200mm arranged thwartships across the void space. On the opposite side of this plenum arrange two further branches, each nominally 425mm x 125mm and disposed as shewn. Arrange for them to penetrate into the cleaners' room before rising and doubling back to enter the hall at the same height as the supplies at the opposite end of the hall.

Replace the pair of existing high level supply grilles by a pair of extract grilles. Allow also for renewing the plenum boxes. Extend on from each plenum box in 300mm diameter duct to form an extract. Immediately on exiting the building arrange for the ducts to rise to high level as shewn to provide access to the AHU and the other equipment. Interpose attenuation and arrange for the two extracts to combine, enlarging to 400mm diameter before directing the duct via a transformation piece and flexible joint onto the inlet of the AHU.

Interpose in the supply and extract ducts a motorized control damper which permit isolation of one end of the hall from the other.

Insulate all ductwork, wrap and clad external ductwork, wrap ductwork under the floor.

4.4 Air Handling Unit

The Contractor is to allow for the supply, delivery and installation on the flat roof between the two halls of an outdoor double decked air handling unit, located in the position shewn on the drawings. Locate unit on two continuous lengths of new sleepers to spread the weight over the roof structure. Ensure all access doors may be opened and sufficient fall is obtained for drains.

The unit manufactured by *Air Design (UK) Ltd* (01384) 720460 – contact Mr James Newell – however, the Contractor should note the details as now specified differ slightly from quotation reference No. Q02268-Rev-02.

Air handling unit is to comprise in the order of air flow:–

Lower deck - supply:- Panel Filter G4, plug fan, LPHW heater battery.

Upper deck - Extract – Panel G4 filter, plug fan

Interposed between the fans and the filters on both decks will be a thermal wheel.

Both fans one to be provided with PWM inverter control and are to be able to vary from nominally 50% to 100% of air flow – supply and extract rising and falling together in response to the size of the hall in use.

Supply	0.53cu m/sec	@ 340 Pa external	motor c.3kW
Extract	0.53cu m/sec	@ 240 Pa external	motor c. 2.2kW

A leakage allowance of 10% has been included in the above air flows giving design flow rates of 0.48cu m/sec.

Provide back draught dampers - may be in unit or in ductwork.

Fans to be fitted with induction drive ‘plug’ type motors driving backward around centrifugal impellers complete with rigid welded steel base frame. Base frame is to be fitted with anti-vibration mountings. Ensure that these compression spring anti vibration mountings, will provide an isolation of at least 95% *for all points* of operation.

The motors are to be fully enclosed, forced air cooled, thermister protected and suitable for PWM inverter drive over the full speed range envisaged.

Provide each fan with a flexible connexion on the outlet and ensure that it has been statically and dynamically balanced following manufacture.

The air handling unit must be designed and installed such that all sections which contain items which require removal for maintenance *e.g.* filters are configured for ready access.

This also applies to the LPHW coil – this will not extend the full width of the AHU – please refer to the manufacturer. The coil is to have slide tracks for side withdrawal.

Provide pressure tappings and manometers so that the pressure drop across each filter bank may be monitored by means of sloping tube manometers.

Heating of the supply air will be by means of heat reclaim from the extract air via a thermal unit which forms part of the AHU together with a LPHW heater battery. The battery has been sized on the understanding the fluid on the secondary side of the heat pump is pure water.

The materials of manufacture must not support microbiological growth: this includes surface finish, mastics, gaskets, insulation, sealants etc.

4.5 Filters

Supply and extract air will be fitted to **G4** standard.

A complete set of duplicate filters in addition to those present in the air handling unit is to be provided by the contractor and handed over to the client.

4.6 Ductwork

The contractor shall supply and install the whole of the ductwork for the supply and return systems, complete with supports, grilles, diffusers, plenums, transformation pieces, and all other associated materials. Duct runs shall follow the drawings except where local conditions necessitate a revision of the layout. Any such changes shall be subject to the prior inspection/comment of the Engineer.

All dimensions and positions of plant and ductwork shall be checked on site and the contractor will be responsible for preparing his own final layout and dimensional drawings. Ductwork layout drawings shall be passed to the main contractor at the earliest possible date for co-ordination with other trades.

The ductwork will be rectangular and in accordance with *DW/144*.

It shall be to the nominal cross section sizes shown on the drawings and based on *DW/144* standard sizes and thicknesses, although the sizes themselves will be non-standard. Minimum nominal sheet thickness is not to be less than .024" (.6mm) - this is acceptable, as regards ductwork passing through fire barriers to Building Regulations. It is to be of mild steel fabricated from hot dipped galvanized sheet to BS EN 10143 - Grade Z2 G-275 coating.

For construction of the ducts the design mean air velocity in all extract and supply mains can be taken as being not over 5 m/sec and that for the supply and extract branches as not exceeding 4½ m/sec. It may be considered as being low velocity.

The contractor's attention is drawn to the requirement to comply with the HEVA *DW/TW2 Guide to Good Practice - Internal Cleanliness of New Ductwork Installations*. The installation shall be installed to the **highest** level of cleanliness including site storage requirements and daily protection of unfinished work. All ductwork shall be thoroughly degreased and cleaned prior to erection. The contractor is advised to liaise with the ductwork manufacturer in respect of this item.

Where site cutting of ductwork is necessary, all cut edges are to be treated inside and out with a cold galvanizing solution and primer. All mild steel angle or other sections etc used to strengthen or support the ductwork shall be finished with red oxide primer.

Where ductwork passes through block or brick walls it shall be painted with black bitumastic paint - this is to prevent acidity of cement corroding the ductwork.

The contractor will be responsible for the provision of all supports for the ductwork and the installation of the supports, shall conform to *DW/144*.

Fittings shall comprise standard arrangement to *DW/144*. Wherever possible long radius bends, large radius main branches, not more than 45° angle sub-branches and long taper transformations shall be used. Bends and offsets shall have a minimum throat radius equal to the depth or the width of the duct depending if they are hard or soft bends. Branches shall be made using 45° spigot or 90° shoe branch connexion. Connexion between duct sections and to equipment and shall be made with angle flanged joints.

Ductwork must be fire-stopped where it penetrates fire compartment walls, floors, cavity barriers and enclosures. It shall be provided with weatherproof collars where roofs or external walls are penetrated. All holes around ductwork penetrating walls shall be padded with suitable sound-absorbent and fireproof material. The packing material around the ductwork must have a fire resistance at least equal to the compartment wall, 'out of flow' type fire dampers shall be provided in ducts at points where they pass from one fire compartment to another.

4.7 Plenum Boxes, Discharge Diffusers and Return Air Grille

The supply diffusers will comprise 4off wall diffusers type *WUCAVO* with double deflection extruded aluminium blades as manufactured by *Solid Air Ltd* (0161) 929 3939. Install each diffuser - nominal size 425mm x 125mm high, finish white – on similar sized duct branches serving as plenum boxes – as shown on the drawings.

Extract will be effected by means of 2off egg crate grilles type *HRECV* wall return diffusers – nominal size 525mm wide x 325mm high, finish white – on similar sized duct branches serving as plenum boxes – as shown on the drawings. Dimensions of the extract grilles, which are to replace extant supply grilles are approximate and should be confirmed before ordering.

4.8 Access Openings, Panels and Covers

Access openings, panels and covers shall be provided to the sizes, requirements and positions recommended in *DW/144*, utilizing suitable proprietary products which meet the relevant pressure classification and one provided with an airtight seal formed from a soft neoprene gasket. They shall be insulated on the supply ducts.

The contractor is to ensure that access opening and/or panels are provided adjacent to filters, heating and cooling coils, fans, humidifiers, attenuators and *all* dampers to facilitate easy cleaning and maintenance.

4.9 Control Dampers - Manual

Control dampers shall be of a proprietary make and generally to the requirements of *DW/144* and installed where shown on the drawings. They shall be of the multi-blade opposed blade type having an 'aerofoil' section. The blades are to be arranged so that they operate in unison from a single lever or hand wheel, incorporating self-lubricating bearings. Dampers are to be provided with a scale or quadrant clearly indicating its degree of opening as well as the shut position and the fully open position. Each damper is to be provided with a means of locking its setting. Following final balancing each scale or quadrant is to be permanently marked indicating its final set position

Adjacent to each damper, fit an access or inspection door so that the operation of the blades may be observed. Dampers must be so aligned and positioned that their operating levers or handwheels remain accessible after the installation is complete.

4.10 Control Dampers - Motorized

The control dampers isolating the supply and extract air to permit operation of part of the hall will be heavy duty duct dampers of the *low leakage* type as manufactured and supplied by *G D L Air Systems Ltd* (01457) 861538. Dampers to be fitted with opposed blade action, airfoil blades, nylon bearings and provided with extended spindle for motorization. Casings to be provided with spigots and be complete with blade and side seal gaskets. At a differential pressure of 500Pa the damper leakage is not to exceed 9l/s per sq m.

4.11 Fire Dampers

Fire dampers shall be installed to meet the requirements of *HTM 81* and where shown on the drawings. They shall be of the multi-blade curtain type with stainless steel blades completely out of the air stream and certified that they comply with BS 476: part 20.

Each damper shall be complete with building in frame and manually reset. They shall be retained by a thermally actuated device set at 165°F (74°C) and designed to provide rapid closure on release BS 5588: part 9 refers. Provide each fire damper with an insulated access hatch to enable resetting of the damper.

Fire stopping, between the damper frame and the structure to which it is fitted, shall be carried out by others. The contractor shall pass the fire dampers to the main contractor for building in.

The contractor shall demonstrate to the Engineer or his representative, the mechanical operation of each fire damper. Replaceable thermally actuated devices shall be included for.

Note:- *Intumescent fire dampers are not permitted with steel ductwork.*

4.12 Flexible Joints

Flexible joints shall be provided at fan inlet and outlet connexions, at the inlet and outlet connexions to the air handling unit and at all other positions shown on the drawings. They shall be equal in cross-section to the points of connexion and not longer than 10" (250mm) nor shorter than 2" (50mm) and they are to be complete with galvanized mild steel backing flats drilled to suit flanges or fitted with proprietary flanges.

The flexible joint is to be formed from neoprene coated glass fibre or other materials having fire resistant properties of 30 minutes integrity. Class 1 surface spread of flame to BS 476: Part 7 and not produce smoke or toxic fumes if involved in a fire.

Care must be taken to ensure they are installed without undue deflection or slackness between correctly aligned ductwork and flanges or spigoted connexions.

4.13 Flexible Ductwork

Lengths of flexible ductwork shall be used for the final connexion to grilles and diffusers *only* if shewn on the drawings

They shall be of a quality such that they provide a standard of tightness equal to that of the ductwork and constructed to meet the fire precautions recommended in BS 5588 which comprises:-

Lengths of flexible ductwork shall not exceed 2'-0" (600mm) in length nor pass through fire compartment walls, floor or enclosures of sub-compartment walls or enclosures or cavity barriers.

The fire resistance of flexible ducting must meet BS 476 part 6 with indices of performance not more than $I = 12$ and $i = 6$. Additionally it shall not produce smoke or a toxic fume hazard if it is involved in a fire.

4.14 Noise Control

With the ventilation system alone in operation and with all of the diffusers and extract grilles in use the acoustic environment within the hall is not to exceed NR25.

When incorporating the attenuators, the Contractor is reminded the installation has variable speed supply and extract fans so it may be at its noisiest at some intermediate speed.

Attenuation shall be incorporated into the main supply and extract ducts as necessary to reduce the noise from the fans to achieve the stipulated limits.

The acoustic infill shall be inorganic, inert, vermin-proof, non-hygroscopic and non-inflammable and complying with BS 476 parts 4 and 24, with a fire propagation index of not more than $I = 12$ and $i = 6$ to BS 476 part 6.

All attenuators shall be provided with a sound-absorbing in-fill, protected by a perforated sheet metal casing. Absorption of moisture, dirt and corrosive substances into the 'in-fill' and the release of fibrous particles into the air stream shall be prevented by the use of a membrane. This membrane must have a declared service life of at least 25 years. Cleaning access is to be provided at both ends of each attenuator section, further the attenuators must be so located that sound attenuating material is not nearer to a fire damper than 40" (1000mm) and is not fitted anywhere after the secondary filter unless shewn in the drawings.

4.15 Inspection of Ductwork

The contractor shall ensure that no foreign debris or material is left in the ductwork after final erection. An inspection will be made by the Engineer to ensure that the whole of the ductwork system is internally clean and free of foreign materials and debris. Any defects due to bad design, materials, suspect leaking joints or workmanship shall be rectified at no cost to the client.

4.16 Leakage Testing of Ductwork System

Leakage tests shall be applied to erected sections of ductwork once complete with access doors. The tests shall be carried out generally in accordance with *DW/144* using portable fan test equipment.

4.17 Overall Noise Levels

Shall be checked and recorded during commissioning to ensure both internal noise levels have not been exceeded, also that the external noise is acceptable.

4.18 Air Flow Rates

The Contractor shall allow for the setting and locking off all dampers and deflector plates after the required air flow rates have been obtained. Such settings shall be recorded in the operating and maintenance manuals and clearly indicated by means of an engraved or painted mark on the damper setting quadrant, or outlet device.

4.19 Testing

Air flow measurement tests shall be carried out on the installation. The contractor is to provide test points in the main supply and extract duct runs to enable the air flow rates to be determined at maximum fan speeds with all of the bins in use and for three other intermediate speeds. The locations will be agreed during the course of the works but allow for 30 velocity measurement points per duct per fan speed.

All of the necessary instruments and probes for the airflow measurements shall be provided by the Contractor, who shall also provide copies of the Test Certificates for the appropriate ventilation system.

4.20 Insulation and Identification

Following final inspection of the ductwork installation, all of the external ductwork – supply and extract – will be insulated, wrapped and clad – aluminium stucco finish, while all of the internal insulation will also be insulated, some will in addition be wrapped.

Duct insulation is to comprise Class O reinforced aluminium fibre glass ‘Lamella Mat’ of 50mm thickness. The insulation shall be wrapped around the ductwork and bonded to it with a recommended adhesive, applied in accordance with the manufacturer’s instructions.

All insulation joints shall be sealed by means of matching aluminium self-adhesive tape 100 mm wide. Any exposed edges of insulation and other points where the foil covering is penetrated or otherwise incomplete *e.g.* duct supports are to be sealed with a suitable mastic sealant.

In addition all external ductwork and the section of internal duct underneath the floor will be protected by wrapping in a layer of high molecular weight polyisobutylene (PIB) sheet - minimum thickness 0.032ins/0.8mm - as manufactured by *Plysolene Ltd* (01403) 713555. Install in strict accordance with the manufacturer's recommendations paying particular attention to the end and circumferential laps using *Plysolene Welding Agent E* applied with a stiff brush.

Take care to obtain a watertight envelope over the complete installation with no loose seams or flaps.

The installer must ensure that the aluminium cladding is so installed as to shed water and is completely waterproof. Installation and thickness of the cladding shall be in accordance with BS 5970: 1992 sections 26, 27 and table 5. The sheet material and preformed fittings shall be applied directly to the external surface of the insulation and all joints lapped ‘weatherwise’, secured by metal rivets at 150 mm centres. Reference to BS 5970 shall be made with regard to compatibility between screws/rivets and cladding. All longitudinal and circumferential overlaps shall be a minimum of 40 mm.

When cutting and forming insulation, the Contractor shall make due allowance for adequate access to fire and control dampers, doors, sensors etc.

The location of all fire, control and regulation dampers shall be identified on their respective ducts and, in the case of hidden ductwork, additionally at a visible location on adjoining exposed building fabric. Supply and fit coloured panels etc. to record the position of all such devices.

Section N° 5

Controls

5.1 General

This section of the Specification related to the design and modus operandi of the controls and their associated systems.

5.2 Control System

The controls will be based on the equipment provided by Mr Ian Ford of *Building Control Maintenance* (07836) 749401 who will also commission them.

5.3 Modus Operandi

Normally plant will be off *i.e.* hall not in use.

Users will initiate operation of the installation by moving a switch from 'off' to 'small hall' or 'large hall' via the local control panel. On receiving a start signal in this way, the supply and extract fans will be activated along with the thermal wheel, LPHW heater battery control valve and the circulating pump.

Speed attained by fans will be determined by the 'hall position' setting – small hall 0.24cu m/sec (supply and extract isolation dampers shut), large hall 0.48 cu m/sec – isolation dampers open. Fan speeds will modulate to maintain these values, adjusting with time as the filters foul.

Room supply air temperature, which is nominally 21°C and identical to the room set-point value in the LPHW fan convector heaters in the room, will be programmed internally in the controls. Slight adjustment of this value will be afforded via a manual adjustment on the local control panel. The heater battery has insufficient capacity to warm the room; it is intended only to warm the supply air to the same temperature as the room to minimize the sensation of draughts by the occupants.

In operation, whenever the outside air temperature is less than the room temperature sensed via the extracted air, then the thermal wheel will transfer heat from the extract into the supply. The heater battery will modulate its output to maintain the supply air temperature at 21°C. Should the extract air temperature rise to exceed 21°C then the heater battery will reduce its output.

To protect the LPHW heater battery from freezing the external ambient air temperature sensor will be used. On detection of a low temperature – nominally 3°C, but adjustable, and plant out of use – the control valve will open and the pump started thereby water will be circulated through it.

5.4 General

The Contractor shall allow for the supply delivery to site and installation of main and local control panels which will be installed in positions agreed with the client.

The panels shall be supplied pre-wired with all electrical wiring, starters, isolators, indicator lights etc in accordance with the requirements of this specification, the IEE Regulations and all amendments, and BS 5486: Part 1 *Factory Built Assemblies of Switch and Control Gear*.

The Contractor is to obtain from the specified specialist controls Sub-contractor a schematic mechanical and wiring drawing which shall be forwarded to the Contract Administrator two weeks before any manufacture of the control panels.

All cable types, number of cores, individually screened or collectively screened must be specified. Also, any limitations on cable length must be highlighted.

The electrical loadings of all motors (eg pump and fan motors) are to be confirmed before the manufacture the control panels. The methods of starting must be clearly identified.

The layout of the panel shall, as far as is practicable, provide for the grouping of items related to individual plant.

Enclosures: The control panel enclosure shall be constructed from sheet steel folded and seam welded to provide a self-supporting structure. The sheet steel will be strengthened when necessary to prevent distortion when supporting heavy instrumentation etc. No sharp edges or corners will be allowed.

Wall mounted panels shall be 0.060"/1.5mm minimum thickness of sheet steel with floor mounted panels 0.080"/2.0mm minimum thickness of sheet steel.

The panel enclosure shall be finished with a stove enamelled colour of a pale neutral tint such as cream, grey etc., with the internal part finished with stove enamelled white. All parts of the panel white will be pre-treated with epoxy primer.

Panels with high heat emitting items of equipment will be adequately ventilated by mechanical means if natural ventilation will not suffice by means of suitable number for fans.

The panel shall be securely bolted to the wall and if floor-standing, it is additionally to rest on a builder's work concrete up-stand. Stand off channels of galvanised steel will be fitted to the rear for mounting to wall fixings, and enclosures shall be finished to IP54 standard.

Doors: Doors shall be structurally sound with necessary stiffening to prevent distortion and provided with full height hinges Each door will have a suitable gasket seal fitted to the main enclosure. Locks shall be provided with lever handles using one common key for, all the of the panels for any one Client. Supply four keys per panel. Provide a locking facility to enable the doors to be locked off by an authorised tradesman in accordance with the Electricity at Work Act. All doors to 240V compartments shall be mechanically interlocked with the main electrical panel isolator.

Labels: All switches, lamps etc on the front of the panels shall be provided with engraved labels bearing black characters 3/16" high on a white background - *Traffolite* or similar - identifying the purpose of device. Items in the panel interior shall be identified in accordance with the schematic drawings, with permanently inscribed labels.

Starters: Starters are to be provided for the motors of all equipment associated with each control panel. Each DOL starter up to 5.6kW is to be contactor type complete with appropriately rated HRC fuses of the 'motor starting' type, or a MCB with similar back up protection characteristics and thermal overloads with protection against single phasing. The coils of all starters are to be rated for 24V AC and all operating and interlock circuits are to be at this voltage.

A red 'trip' lamp and a green 'run' lamp shall be provided for each starter.

Auxiliary contacts are to be provided as necessary.

Manual control switches will be as specified in the appropriate clause.

All overloads to be rated mid-span for the full load current (FLC). 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.

Where auto-changeover is specified, each motor is to have its own starter and associated lamps, switches, fuses, etc., all as specified above. An additional N° 1/N° 2 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.

Motor control gear overloads shall only be able to be reset from inside the panel unless otherwise specified.

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 panel, sequence starting delay timers are to be provided to reduce the maximum instantaneous current as necessary, when started under automatic control.

Indicator lamps: Indicator lamps shall be of the LED type 3/8" (10mm) diameter. LED lamps shall be according to the following:-

Panel live	clear
Run or on	green
Faulty or trip	red
Set back	amber

The bezels of all LED lamps shall be not less than 3/4"/20mm diameter.

All 'fault' and 'trip' lamps to be automatically extinguished in the event of rectification of the malfunction, or the control switch of the affected device being moved to the off position.

Securely fixed within the panel shall be a minimum of 10 per cent or 3 in number (whichever is the greater) spare lamps of each size and type of lamp used within the panel.

Lamp test facility will be required on all panels.

Control Circuits: All control circuits to be 24V, and to be taken from the blue phase of the control pane supply, protected by a sub-fuse complete with integral indication of fuse failure.

The transformer feeding control circuits shall be such as to ensure that the output voltage is capable of operating all control circuits on simultaneous operation *ie* the voltage regulation of the transformer must be capable of operating all control circuits simultaneously.

Computer Socket: All control panels shall contain a 13 amp RCD 30mA protected single gang switched socket outlet, labelled 'for computer use only'.

Indication Switches: All single items of plant shall have an individual hand/off/auto switch where applicable *ie* boilers.

Multiple items fitted up as run and stand by *ie* duplicated pumps, shall have a system control hand/off/auto *and* a manual selector switch.

All switch indicators will have auto changeover for all dual pump sets switched to 'Auto' via software duty cycling facility.

Placing a switch in the 'hand' position shall enable the pumps, boiler etc to operate continuously, however operating the plant in hand shall only disable the time control, all other control functions, and safety interlocks shall remain functional. Conversely, when the switch is placed in the 'auto' position the items of plant shall be controlled in accordance with the time and optimisation schedules.

Cabling: All cables shall be sized appropriately for their application and loading.

All wiring to be numbered.

All cables to have crimped ends. Sensors and detectors to be wired in 22 awg twisted pair individually screened cable.

Wiring shall be enclosed in slotted plastic trunking. The number of cables in any one trunking shall not exceed 45 per cent of the trunking maximum capacity.

Where cables leave the trunking for a termination, then sufficient cable length shall be left to enable the connexion to be re-made a minimum of twice.

Where wiring crosses a hinged door, it should be loomed in such a manner as to cause twisting, rather than bending of the wires, and shall be of the multi-strand flexible type.

All three-phase and neutral supplies shall be fitted with individual neutral links.

Power cables to be rated to the full load current according to the IEE Wiring Regulations - current edition.

Terminations: All cables shall be identified at both ends by threaded cable markers threaded to read outwards from the wire end. The unique identifying numbers shall be the same as those shown on the wiring diagram.

Segregation of voltages: The panel/enclosure shall be split such that all voltages of less than 240V ac are enclosed within a separate compartment in the panel, to enable work to be carried out on the BEMS controls section without exposing the mains section of the panel.

Wiring diagrams: One complete as fitted copy of the schematic wiring diagram for the panel shall be placed within each control panel. Securely stored folded within a pocket attached to the inside of the panel.

The control panel is to be fitted with the following items on its front door:-

Air handling unit	Hand/off/auto Fan on and fan 'fault' lamps <i>e.g.</i> motor trip
Speed controllers (AHU)	The variable speed controllers for the fan motors are to be capable of being by-passed in the event of inverter failure, with the motors run at full speed.
Temperature & fan speed	Continuous indication (digital) of the temperature within the hall and the fan speeds
Fire alarm	Fire alarm/ventilation plant interlock - the plant is to continue running in the event of activation of the fire alarm system. However, provide the means, so that if the Fire Officer should demand it, one or both of the fans may be stopped in the event of a fire alarm.
Indicator lamps and alarms	Illuminated when activated 1 off red – alarm condition* 1 off green - plant in normal operation 1 off amber – stand by *Actual alarm condition (<i>eg</i> ventilation fault, filtration fault etc) to be determined from interrogation of the controls.

All 'fault' and 'trip' lamps to be automatically extinguished in the event of rectification of the malfunctions, or the control switch of the affected device being moved to the off position.

5.5 Local Control Panel

The hall is to be provided with a local control panel provided with the following:-

Indicator lamps	Illuminated when activated 1 off red – alarm condition 1 off green – plant operating correctly (extinguished if alarm detected) 1 off amber – stand by mode
Temperature	Continuous indication (digital) of temperature within the hall.
Air flow adjustment	Three position switch for users to adjust air flow – off, 'small hall' and 'large hall'
Temperature adjustment	Provide means for users to trim room temperature two degrees either side of set-point value (initial adjustment range 19°C-23°C). Set-point temperature (21°C set by controls)

Corresponding nominal air flow rates for the three-position switch, 0 cu m/sec, 0.24 cu m/sec and 0.48 cu m/sec respectively.

5.6 System Power and Control

The installation of all cables, in connection with the function room and external to the control panels - power/control/sensor – will be the responsibility of the electrical contractor. Cables are to be installed in accordance with a cable schedule supplied by the controls supplier, with a copy forwarded by the Contractor to the Engineer. The final connexions to these items will be checked by the controls supplier as part of his commissioning process.

Hall ventilation	2 off duct air temperature sensors 2 off duct air velocity sensors 2 off variable speed outputs to fan motors with harmonic and RFI suppression 2 off motorized dampers 1 off control valve – modulating 1 off supply to circulating pump 1 off frost sensor
Miscellaneous	1 off fire alarm input

All of the temperature sensors are to be of the close tolerance thermistor type.

5.7 Location of Sensors

All sensors shall be located generally in the positions shewn on the drawings, but their exact location will be agreed between the Contractor, Engineer and the controls supplier. The positions will be determined with a view to obtaining good control stability, representative indication of the controlled medium and accessibility for maintenance.

The Contractor is to install the sensors but their wiring and termination will be done by others.

5.8 Location of Sensors

All sensors shall be located generally in the positions shewn on the drawings, but their exact location will be agreed between the Contractor, Engineer and the controls supplier. The positions will be determined with a view to obtaining good control stability, representative indication of the controlled medium and accessibility for maintenance.

The Contractor is to install the sensors but their wiring and termination will be done by the controls supplier.

5.9 System Operations and Commissioning

Site Visit During the installation of the controls the control supplier will allocate at least 1 day on site to assist with the positioning of control equipment and agreeing sensor positions confirming types of wiring etc.

Commissioning All controls will to be checked for correct operation. As part of the commissioning procedure, the Contractor/controls supplier will be required to check the operation of the plant during the maintenance defect period of twelve from practical completion. This will enable the operation of the controls to be monitored under all conditions. During this period the controls supplier will be required to carry out any necessary fine-tuning of control settings requested by the Client.

Trend Logs To assist in this trend logs shall be set up as necessary, by the controls supplier. At a minimum, these shall be able to monitor room temperature, fan speed and humidity.

Controls Logic The controls supplier will be expected to modify control logic in the light of operational experience by the Client, and in respect of his own analysis of the recorded data.

Copies of all recorded information will be forwarded to the Client. These adjustments may be made remotely by modem or on the occasion of his visits to check on the installation.

Bureau Service To accompany this monitoring and supervision of control and system performance, the controls supplier will be required to provide a bureau service for the Client. Should the Client, for whatever reasons, being unwilling or unable to alter a control parameter or schedule, upon receipt of a telephone call, the controls supplier will perform the operation promptly on his behalf. This shall also encompass those software changes needed to modify control logic in the light of operational experience by the Client.

Manuals Provisional operating and maintenance instructions and 'as commissioned' wiring diagrams and schematics will be submitted at practical completion of the project. Final manuals and drawings will be submitted for the Health and Safety file at handover, incorporating any modifications carried out to wiring or control settings during the maintenance period.

Operations manuals should describe simple day to day procedures for the level of competence necessary to alter temperatures and timetables and deal with alarms together with more technical data on changes to the system operation and graphics.

Training Satisfactory training of client personnel will include instruction on the sequence of operation of the controls, basic fault finding and simple remedial measures coinciding with the provision of the initial operating and maintenance instructions. Such training would be expected to take at least two man days which may be split over several visits to site and should conclude with site staff able to operate the control equipment at a basic level while understanding the operations of the control circuits.

Section N° 6

Electrical Installation

6.1 General

This section of the specification relates to the electrical works in connexion with the ventilation installation.

6.2 Extent of the Works

The work included in this section comprises:-

To reposition and re-commission certain items of electrical equipment which are to remain in use.

To provide an electrical supply to the AHU

To install the cabling between services, actuators, pumps, fans, control devices etc and the controllers, control panels etc.

The whole of the electrical works and all of the equipment connected to it shall be earthed in accordance with IEE Regulations. Supplementary bonding conductors not less than 6sq mm shall be provided connecting items of extraneous metalwork and the main bonding conducting *e.g.* hot and cold water, gas and heating services.

All mains voltage supplies etc shall be installed with a continuous circuit protective conductor throughout.

Armouring and metal sheaths shall be connected by a bonding conductor directly to the external earthing terminal of the equipment at all terminations. Irrespective of the connexion of the armouring all LV cables will be provided with a cpc/bonding conductor laid alongside and clipped to it. The cross sectional area of bonding conductors for LV cables shall be calculated or sized in accordance with Table 54G of BS 7671: and HV cables it shall be to BS 7197.

Continuity and insulation tests shall be carried out during construction. On completion, polarity, bonding, earth loop impedance, continuity and insulation tests shall be carried out on the new work in toto. Following satisfactory testing duly completed certificates as prescribed by the IEE Regulations shall be provided.

6.3 Characteristics and Co-ordination

The Contractor shall assess the general characteristics of the installation in accordance with Part 3 of the IEE Wiring Regulations and shall design his installation taking that assessment, Statutory Regulations and this specification and drawings into account.

Cables/conductors and protectors (including earthing) installed or adapted by the Contractor shall be properly co-ordinated within his installation and to the existing installation. This shall include meeting the IEE Wiring Regulations cable sizing requirements for current rating and voltage drop limits. For voltage drops estimations, cable sizes shall be determined taking into account the effects on equipment terminal voltage of both the equipment load itself and also other loads or plant on its electrical installation which may affect that voltage.

Notwithstanding these requirements, the voltage at final circuit equipment terminals shall be in accordance with the relevant equipment BS, or where none exists, then in accordance with the equipment manufacturer's recommendations.

The Engineer may at any stage of the Contract require proof, that these requirements have been met, in the form of calculations and/or manufacturers' data. Installation work on site shall not commence unless the proofs are held - by the Contractor, and are available for inspection, whether or not the Engineer has at that stage requested sight of them.

Following acceptance of his tender, the Contractor shall submit information to the Engineer shewing the proposed arrangements of circuits (including links to existing) and cable design data. The cable data may be in the form of a cable schedule.

6.4 Segregation of Circuits

Notwithstanding the requirements of the IEE Wiring Regulations, independent electrical systems shall be provided for following:-

- (i) Mains voltage lighting and power
- (ii) Internal telephones
- (iii) External telephones
- (iv) Fire Alarm Systems
- (v) Safety lighting (centralized batteries)
- (vi) Building energy management system

In no instance shall LV (Category 1) and ELV (Category 2) circuits be enclosed in the same trunking compartment or the same cable containment system, the same conduit system or the same multicore cable.

6.5 Removal of Redundant Equipment and Installations

The Contractor shall allow for the **complete removal** of all redundant electrical fittings, detectors, accessories, luminaires, sounders, conduits, cabling, trunking etc. right back to the distributions board, control panel or switchboard which served as the origin for that particular circuit or circuits. Allow also for the removal of any redundant mechanical items and builder's rubbish etc associated with the works.

6.6 Mutual Detrimental Influence

Electrical installations shall not be installed in contact with any steam, water, gas or other pipework, or any heating or ventilation ductwork or appliance. A minimum distance of 4" (100mm) shall be maintained from the installations of pipework or 6" (150mm) from uninsulated pipework. These minimum clearances shall also be applicable when rigid cable containment systems run adjacent to any heating pipework, ductwork or appliance.

6.7 Occupation of Adjoining Rooms & Temporary Supplies

The Contractor should note that for the duration of the Works, the adjoining rooms within building, as well as all of those also served by circuits from the switchboard will remain in use. The Contractor must maintain electrical services to those areas in which he is not working, but which share common electrical supplies with the area in which he is.

6.8 Installation Type

The modifications to the existing mains voltage installation shall match the existing installation which comprises pvc sheathed/pvc insulated cables, clipped direct in plant rooms, voids and the like and accommodated in chases elsewhere to give a flush installation in the habitable rooms.

External to the Building: Cable drops to the AHU, control actuators sensors *etc* located external to the building and of necessity exposed to the elements shall be run in pvc/swa/pvc (LSF pattern) cables and surface mounted plastic conduits supported from and clipped to cable tray. All pvc conduits used externally shall be **black finish** 20mm diameter.

Note:- Any form of mini-trunking either internally or externally will not be accepted.

6.9 Point of Commencement

The point of commencement for the works is the distribution board located in the first floor plant room.

6.10 Final Circuits

The final circuit cables shall be from the '*Smoke Master*' range as manufactured by **BICC Construction Cables**.

All cables shall be correctly colour coded and 450/750v standard.

In all circuits, the cpc shall be the same cross-sectional area as the phase conductors.

Ring mains 2½□mm, lighting circuits 1½□mm.

No mains voltage cable, and comprising part of the fixed installation, may have conductors with a cross-sectional area of less than 1½□mm other than the cpc in pvc insulated/pvc sheathed lighting circuit cables.

No intermediate joints will be permitted. Cables must be installed on the 'loop in' principles.

6.11 Controls and Control Panels

The Contractor is to install in the positions shown on the drawings a control panel provided by the Controls supplier.

Location of Sensors: All of the sensors shall be located in positions agreed with Contractor, Engineer and the Controls systems supplier. The positions will be selected with a view to ensuring good control stability, representative indication of the controlled medium and accessibility for maintenance.

Control Cables: Control cables – sensing and data – shall be *Belden type 22awg (7/·25□mm)* one or two twisted pair with drain wire and overall screen – or as stipulated by the Controls supplier.

Control cables – power (low voltage 24Vav/0-10Vdc) – shall be pvc insulated/pvc sheathed.

Cable Identification: Sensor and control cables shall be colour coded and identified strictly in accordance with requirements of the Controls supplier. The ends of all cables shall be labelled in a standard and consistent manner. Cable markers shall be of the "thread on" type and may be heat shrinkable. Wrap around type or cable markers made from adhesive type will not be accepted.

Cable Connexions: The final connexion of all control and sensor cables will be carried out by the Controls supplier/manufacturer as part of their commissioning process.

Data Highway: It is anticipated the control system for this installation will be nominally self-contained with any interrogation and/or monitoring being obtained via the control panel.

Mains Voltage Supply to Air Handling Unit: Install a three phase mains voltage supply from the control panel to serve the external air handling unit. Provide local isolation (IP65) and ensure that the point of isolation is within 18ins (450mm) of the AHU location.

Provide and install a four-core cable having 10sq mm, copper conductors, LSF/XLPE insulated, bedded, steel wire armoured, LSF sheathed overall, 600/1000 volt grade in accordance with BS6724. Cable is to have a high radio frequency interference screening factor. The cable is to be installed complete with a separate earth/cpc of 10sq mm laid alongside and clipped to it to serve in addition to the earthing provided by its armouring.

Cable is to be supported on cable tray within and without the building. Externally support on cable tray run alongside the extract ductwork. The tray is to be supported entirely off the duct support frame and/or the building envelope not from the ductwork.

Internal Mains Voltage Supplies to Pump: Mains voltage cables serving pumps, valves, fans etc located in floor voids, subways crawlways, plant and boiler rooms shall be run in pvc/swa/pvc using SY Cable complying with the requirements of BS 6500 and VDE 0250. SY cable is also known as flexible or braided control cable.

Provide pump with local isolation to IP54.

Where two or more cables run together install on traywork - tray may be secured to the ceiling or soffits in the floor void spaces to secure unobstructed runs.

6.12 Fire Barriers

Where cables, conduits, trunking and cable trays pass through fire resistant structured elements such as floors and walls designed or designated as fire barriers, the openings shall be sealed by the Main Contractor to the appropriate degree of fire stopping. In addition, where cables or conductors are installed in channels, ducts and trunking, which pass through such elements, internal fire resistant barriers shall be provided by the Contractor to prevent the spread of fire.

6.13 Labelling

Each socket outlet, connexion unit, lighting switch, isolator, distribution board, etc is to carry a permanent label, bearing letters in black on a white background.

Labels to be of a similar design to the existing – engraved or printed, as necessary, providing the same information:-

Origin of supply, phase and circuit details.

6.14 Existing Installation

Allow for removing and repositioning the light switch for the first floor plant room luminaire to a more suitable position so that it might be easily operated after the supply duct has been installed.

Allow as necessary for repositioning the accessories currently mounted on the dado trunking to different locations – either on the trunking or surface mounted on the walls and supplied via pvc conduits – so that operation of the equipment they control/isolate is not compromised by the presence of the supply ductwork.

6.15 Inspection & Testing

The whole of the installation shall be inspected and tested in an orderly sequence to ensure that the requirements of the specifications, the IEE Wiring Regulations, the Electricity at Work Regulations and British Standards are met. The instruments to be used conform to the appropriate British standard safety specification BS EN 61010.

The inspector carrying out the inspection and testing of any electrical installation must, as appropriate to his or her function, have a sound knowledge and experience relevant to the nature of the installation being inspected and tested, and of BS 7671 and other relevant technical standards. The inspector must be fully versed in the inspection and testing procedures and employ suitable test equipment during the inspection and testing process.

The Contractor may if he wishes, make use of a commissioning engineer supplied by the manufacturer of the equipment.

Regulation 631.1 of BS 7671 requires that, upon completion of the verification of a new, modified or extended installation, an Electrical installation certificate based on the model given in appendix 6 of BS 7671.

The procedure shall include a visual inspection of the installation including equipment, subways, shafts, ducts, walkways, crawl ways and false ceilings where accessible together with the items as described in the IEE Wiring Regulations. It shall also encompass the operations of all accessories and all items of fixed equipment. These tests are to be conducted under conditions of normal operations and the results noted.

For details of the methods to be followed please refer to paragraph 2.47.

Section N° 7

LPHW Installation

7.1 General

This section of the Specification relates to the provision of a low pressure, hot water heating installation.

7.2 Extent of the Work

The work associated with this section comprises:-

The modification of the existing distribution pipework

The introduction of a circuit to serve the AHU complete with pump

The incorporation of all necessary valves and controls etc for the installations to function in the manner intended

The testing and commissioning of the heating system

7.3 Description of the Work

To avoid disturbing the hydraulic balance of the existing installation at existing 1¼ins flow and return connexions on the buffer vessel, introduce 2off 1¼ins tees. Modify the existing flow and return distribution circuit as necessary in order for it to connect, via isolating valves, onto one branch of each tee to restore the circuit. Reduce the remaining pair of tee branches to ¾in diameter and after introducing a pair of isolating valves, direct them to serve the heater battery in the AHU.

At a convenient point in the flow enlarge the pipework as necessary and introduce a circulating pump complete with isolating valves and by the AHU install a control valve and battery isolating valves.

7.4 Circulating Pump

Size and install a circulating pump from the ranges manufactured by *Grundfos* or *Smedgaard*:-

Pump is to be single head, 240v single phase variable speed unit.

Pump to be capable of delivering 0.06l/sec through the AHU heater battery – water-side resistance of the coil to be confirmed by AHU manufacturer. Fit metering station so that the flow rate may be measured and confirmed.

7.5 Valves and Cocks

The valves and cocks to be used on the heating installation are to be as specified below. Valves, strainers *etc* are to be provided as indicated on the contract drawings and at all places necessary for proper working, regulation, plant protection, isolation, control and maintenance of the installation.

Item	Nominal Size	Description	Standards	Notes
Isolating Valve	½" to 2"	Copper alloy. Wedge gate type. NR stem - handwheel or lockshield as required. PN6 bar.	BS 5154 BS 504 Part 3 Section 3.1	
	½" to 2"	Screwed ends. BS 21 taper	Section 3.2	
	15 to 50	Flanged ends PN6 bar	Section 3.3	

Isolating Valve	65 or above	Cast iron wedge gate type. NR stem. GM trim. Metal handwheel. PN6 bar. Flanged	BS 5150 BS 4502 Section 3.2 Section 3.3	
Check Valve	½" to 2"	Copper alloy. Swing or lift type. PN6 bar. End connections screwed BS 21 taper	BS 5154	
Check Valves	65 or above	Cast iron. Swing type. Bronze trim. PN6 bar. Flanged	BS 5153 BS 4504 Part 3 Section 3.1 Section 3.2 Section 3.3	
Strainers	15 to 54	Bronze with stainless steel screen or mesh. Ends screwed BS 21.	Makers Standards BS4504 Part 3 Section 3.1 Section 3.2 Section 3.3	
	65 and above	Cast iron. With stainless steel screen or mesh. PN6 bar Flanged		
Double regulating valves	½" to 2"	Copper alloy. Angled pattern. Loose key operation. Gunmetal trim. End connections screwed BS 21 taper. PN6 bar.	BS 5154	
	65 to 300	Cast iron. Angled pattern. Gunmetal trim. Rising stem. Outside screw. PN6 bar. Flanged. PN6	BS 5152 BS 4504 Part 3 Section 3.1 Section 3.2 Section 3.3	
Flow metering set	½" to 2"	Copper alloy set with bronze orifice plate and two pressure test points with captive brass sealed plugs and caps. Screwed mounting.	Makers Standards/104 2 orifice	
	65 to 300	Cast iron set with stainless steel orifice plate and test points as above. Flange mounting		
Draining taps	½" & ¾"	Gunmetal. Bush pattern. Screw down with loose handle and hose connection	BS 2870	
Gaskets at Flanges	All sizes	Flat sheet or metal type joint rings	BSEN 1514	Asbestos free material

Double regulating valves to have regulating and indicator devices, and means for securing them. After commissioning, the regulating valves are to be set so that although they may be closed for operational reasons, they may not be inadvertently opened beyond their commissioning settings. Double regulating valves and automatic balancing valves are to be located such that there is a minimum straight distance of 5 times the diameter of the pipe before the valve and twice the diameter of the pipe downstream of the valve. If the valve is to be located after an element creating strong disturbances such as a pump or a motorised control valve, the straight distance before the valve must be increased, preferably to at least 10 times the diameter of the pipe. Do not place elements which could create disturbances in the upstream straight lengths *eg* temperature probes.

For metering stations, a straight pipe length of at least 10 times the orifice plate before and 3 to 5 times the diameter after the orifice plate are to be provided.

Provide 4 off three-port diverting valves - size as per incoming flow pipe diameter - to control the

temperatures of portions of the building. Valves shall be installed allowing sufficient space for access to the linkage, actuator and wiring.

Control valves: Provide 1off two-port modulating valve to control the temperature of the supply air leaving the AHU. Valve to be ½in diameter with a Kv of 1.6; ensure valve is installed with sufficient space for access to the linkage, actuator and wiring. Arrange for the pipework to be so disposed that the valve is facing the ‘correct way’ towards the observer.

7.6 Pipework and Fittings

Tube: The pipework of the existing LPHW installation is in plastic – Hep2O. The new pipework may be installed using the same material or copper. If the contractor elects to use plastic, he is reminded to provide sufficient support to the valves and pump to ensure the pipework is not strained when they are in use. If necessary, to ensure this he may prefer to substitute copper pipes for these sections.

To BS EN 1057 half hard temper R250, Kitemark certified.

Supports: Manufacturer’s standards for the Hep2O pipework.

Brass Munsen split rings with backplates - for copper or copper alloy pipes.

Item	Nominal size	Description	Standards	Notes
Pipe	All sizes mm OD 15 to 159	Copper Tube	BSEN 1057 Table 4 R250 (Table 1)	Material to BS1172 non-arsenical and de-oxidised Grade C 106
Fittings	15 to 54 76 to 159	Copper or non-dezincifiable copper alloy. Capillary type with integral ‘lead free’ solder rings. Copper or non-dezincifiable copper alloy. Capillary type 15% silver/4.8% phosphorous brazing metal	BS 864 Part 2 Makers standards BS 1845 Table 3 Type CP1	Fittings to be marked by manuf’r identifying them as being ‘lead free’ For copper to copper brazing
Unions	15 to 54	Copper or non-dezincifiable copper alloy. Capillary type with integral ‘lead free’ solder rings.	BS 864 Part 2 BS EN 29453	Fittings to be marked by manuf’r indentifying them as being ‘leadfree’
Flanges (two-piece type)	65 to159	MS flange/copper alloy centre piece. Capillary type 40% silver brazing metal. Flange PN6 bar.	BS 4504 Part 3 Section 3.1 Section 3.2 Section 3.3 BS 1845 Table 2 Type AG20	Flanges to have coating against electrolytic action and corrosion

Notes:- Cold water feed pipes must be in copper to comply with Water Authority Byelaws. Use Table 10/06 BSEN 1057 R 250 tube according to duty.

The Contractor is reminded of the need to ensure that whenever a pipe passes through from one fire compartment to another, that the annular space between the pipe and its sleeve is packed with resilient fire stopping material or mastic and chrome plated floor plates are fitted with vents which otherwise would be exposed to view.

Installation to be fitted with vents at high points and drawing taps at low points to facilitate purging and drawing. These are to be fitted at all appropriate points whether shown on the drawings or not.

Form changes of direction with radius fittings or formed bends. Use purpose designed adapters for connecting dissimilar materials; do not improvise. Protect background and plastic pipes and fittings from heat damage when soldered joints.

7.7 Pipe Runs

Refer also to Section N°2.

Runs to be straight and parallel or perpendicular to walls, floors, ceilings, etc as appropriate. Obtain approval of routes before commencing work.

Wherever reasonably possible, conceal pipe runs within floor, ceiling or roof voids.

Run hot pipes above cold where these are routed together horizontally. Do not run pipes through electrical enclosures or above switchgear, distribution boards or the like.

Fix at adequate centres with minimum of bends and offsets.

Allow for thermal movement and isolate from structure where necessary to prevent noise or abrasion caused by movement. Pipes passing through walls to be sleeved specified in Section N°2.

Prevent ingress of dirt during installation.

Completed pipelines to be of consistent bore, clean and free from external scratching toolmarks, distortion, cracks and other defects.

Install and balance the systems so that they comply with the water supply bye-laws/regulations, and are safe, efficient, free from leaks, excessive noise and vibration.

All equipment, pipework, components, valves, etc. are to be fully accessible for maintenance, repair or replacement.

Installation to be fitted with vents at high points and draining taps at low points to facilitate purging and draining.

7.8 Temperature Sensor

Operation of the heat pump is instigated by means of a temperature sensor on the flow pipework. Reposition this sensor to ensure that operation of the heat pump is activated should either circulating pump be in operation.

Configure the tee branch outlet on the buffer vessel to ensure this sensor obtains a good indication of the flow temperature.

7.9 Testing, Commissioning and Balancing

All under-floor pipework shall be tested and left pressurised by its installer.

The primary and secondary circuits shall be subjected to hydraulic tests, generally in accordance with BS 6880 Parts 1 and 2, to twice the working pressure. The Contractor is to shut valves and/or fit blank flanges as necessary to ensure complete isolation from the under-floor pipework.

The testing shall be carried out after a preliminary inspection for leakage with the pipework full of water at normal pressure.

The hydraulic tests are to be applied to the sections of pipework using cold water, the pressure to be held for not less than one hour after the rectification of any leakage.

Include for removing of all blanks, flushing out each section of pipework. Completely fill system, removing all air and check for leaks, bring up to temperature with all circuits regulated for satisfactory flow. Run system to maximum operating temperature and checking for leaks. Allow system to cool, leave in cold condition for at least 3 hours and again check for leaks.

Any leakage during these expansion and contraction tests shall be rectified and the test repeated. Signed test certificates are to be handed to the Engineer prior to handover, as a true record of the tests.

The Contractor may conduct the tests and flow measurements himself provided that he has the necessary experienced staff and instruments available. Alternatively, he shall arrange for the commissioning to be conducted by a competent independent specialist.

All systems are to be set up by the Contractor who shall demonstrate their performance to the satisfaction of the Engineer. All automatic control systems shall be tested to demonstrate that they are capable of meeting the demands specified and shall be adjusted to suit the characteristics of the building.

7.10 Insulation and Identification

On completion, and following testing and commissioning, *all* of heating pipework, within the plant room and externally is to be insulated.

Internally arrange to match the existing insulation.

Externally the pipework is to be insulated in mineral wool 2ins/50mm thick then wrapped in butyl rubber sheet and finished in aluminium stucco cladding.

Waterproof the insulation by wrapping in a layer of high molecular weight polyisobutylene (PIB) sheet - minimum thickness 0.032ins/0.8mm - as manufactured by *Plysolene Ltd* (01403) 713555. Install in strict accordance with the manufacturer's recommendations paying particular attention to the end and circumferential laps using *Plysolene Welding Agent E* applied with a stiff brush.

Take care to obtain a watertight envelope over the complete installation with no loose seams or flaps.

The installer must ensure that the aluminium cladding is so installed as to shed water and is completely waterproof. Installation and thickness of the cladding shall be in accordance with BS 5970: 1992 sections 26, 27 and table 5. The sheet material and preformed fittings shall be applied directly to the external surface of the insulation and all joints lapped 'weatherwise', secured by metal rivets at 150 mm centres. Reference to BS 5970 shall be made with regard to compatibility between screws/rivets and cladding. All longitudinal and circumferential overlaps shall be a minimum of 40 mm.

Coloured identification bands complying with BS1710 together with flow indicating arrows, are to be applied to the pipework at frequent intervals.

Section N° 8

Builder's Work

8.1 General

This section of the Specification relates to the builder's work and its integration with the other works.

8.2 Description of the Work

The Contractor will be required to include for *all* of the builder's work needed in connection with these works. This includes:-

Creation of holes and other penetrations required for the accommodation of pipes, cables, ducts etc. and the making good of the building envelope afterwards

The creation of and/ or modification of openings to receive ducts, grilles, diffusers etc

Fire stopping around pipes, cables, ducts etc

Modifying the floor structure of the plant room to permit the passage of the supply air duct

Provide a base to receive the air handling unit (AHU)

To assist with the removal and location of heavy and/or bulky mechanical and electrical items as may be required, including the hire of a crane to lift the AHU into position

Provision of scaffolding and working platforms to permit the installation and removal of high level items

8.3 Grilles and Diffusers

Form new openings for the supply diffusers and modify as necessary the two extant openings that will form the extract to accommodate the ductwork/plenum boxes.

Introduce suitable lintels into the openings formed for the supply diffusers to support the building structure. Include for making good including decoration.

8.4 AHU Base

Provide a timber base formed from two lengths of railway sleepers to receive the channel longitudinals located one on each side of the AHU. Sleepers to be new, pine and treated of 10ins x 5ins in section and shortened to form a continuous support under the AHU channels.

8.5 Timber Floor

Trim back the joists and otherwise modify the timber floor of the plant room around the vertical ladder to permit the supply air duct to pass through. Include for joist hangers and/or a trimmer to maintain the structural integrity and carrying capacity of the floor following its modification.

8.6 Fire Stopping

Where ducts, pipes, cables, conduits, trunking and cable trays/baskets etc pass through fire resistant structural elements such as floors and walls intended as fire barriers, the openings made shall be sealed to achieve the appropriate degree of fire resistance *i.e.* equivalent to that of the

imperforate element prior to penetration. In addition, where cables or conductors are installed in channels, ducts, baskets or trunking which pass through or otherwise pierce such elements, internal fire resistant barriers shall be provided to prevent the spread of fire.

Internal: Pack the inside of the trunking and basket at each penetration with sufficient intumescent bags to obtain the required fire integrity. Use small bags to enable cables to be readily added or removed at some future date.

External: The annular space between the outside of the duct, pipe, cable or cable containment system shall be solidly packed with an approved proprietary intumescent mastic material or fireboard where appropriate to maintain integrity of existing fire compartments.