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STOURBRIDGE LION MEDICAL CENTRE

MECHANICAL SERVICES SPECIFICATION

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Prepared by: N Patheyjohns

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Signed: 

Signed: 



MECHANICAL ENGINEERING SERVICES

STANDARD SPECIFICATION

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DIRECT SUB CONTRACT WITH MAIN CONTRACTOR

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STANDARD FORM OF BUILDING CONTRACT

PART A - CONDITIONS OF CONTRACT

GENERAL

The section of the Works referred to and covered by this Specification shall all be undertaken by a specialist Sub-Contractor as a Direct Sub-Contractor to the Contractor unless stated otherwise. The work included in the Specification and attributed to the specialist Sub-Contractor is based on current Contract procedure.

The Contractor shall ensure that the specialist Sub-Contractor complies with all sections of the Direct Sub-Contract detailed in this Specification.

2. DEFINITIONS OF TERMS

In this Specification the following terms shall have the following meanings:-

“Shall” is mandatory.

“Will” is informative.

“Should” is advisory.

“Provide” means supply, fix and install.

‘Architect’ shall mean:

Abacus Architects
26 Vittoria Street
Hockley
Birmingham
B1 3PE

‘Engineer’ or ‘Services Engineer’ shall mean:

Arcobaleno Consulting Engineers
Suite 3, Third Floor
104 – 106 Hagley Road
Edgbaston
Birmingham
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'Contractor', 'Specialist Contractor', 'Refrigeration Contractor' or 'Electrical Contractor' shall mean the firm appointed to execute this section of the work.

'The Works' shall mean the whole or a part of the work included in the Contract between the Employer and the Contractor.

'Contract Works' or 'this section of the Works' shall mean the goods, materials and all drawings and any other documents specified to be supplied and the work to be done included in this Specification.

All reference to 'Services Engineer', 'Architect' or 'Structural Engineer' contained within this specification shall be deemed to read 'Employers Agent'.

3. CONTRACT CONDITIONS

The Conditions of Contract for the Main Contract works shall be as specified elsewhere in the employer's requirements documentation. The Condition of Contract between the Refrigeration Contractor and the Client shall be in accordance with the standard Terms and Conditions and the Contract Specification and drawings. The Conditions of Contract/Agreement between a specialist services sub-contractor and the successful Contractor shall be a matter entirely between the specialist and the Contractor.

All necessary details of the Main Contract Conditions, including programme, attendances, general facilities or any other matter shall be agreed between the specialist sub-contractor and the Contractor. The Specialist Sub-Contractor shall become a domestic Sub-Contractor to the Contractor in accordance with the conditions agreed between the two parties.

4. CONDITIONS FOR TENDERING

This document is a Mechanical and Electrical Specification prepared to enable competitive tenders to be obtained on an equal basis. The tenders shall be based on the conditions stated in the main contract document.

The tenderer shall be entirely responsible for the whole of the supervision, installation, commissioning and testing of the systems. The tenderer shall submit with his tender, drawings and specification in sufficient detail to enable an accurate assessment of the tender to be made. The Services Engineer may request further details and information on receipt of the tender documents, and failure to comply with this request will result in the tender not being considered.

The tender price shall be based on a fixed price contract in accordance with the Contractors conditions.

After the tender has been accepted, the tenderer shall prepare installation drawings to scales to be agreed with the Engineer in sufficient detail to enable the other Contractors and Sub-Contractors to prepare their installation drawings and/or details. In preparing these installation drawings, the tenderer must allow in the tender for liaison time with other Contractors to ensure that the drawings which are prepared for the installation are fully co-ordinated with all other engineering services and all structural and building details. In addition, the Contractor shall submit calculations to the Services Engineer to demonstrate that the design is in compliance with the Employers requirements.



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Allowance shall be made for all necessary negotiations with relevant Local/Enforcing Authorities and utility service providers. In all cases, drawings shall be submitted to the Services Engineer for comment prior to any work commencing on site.

The installation and working details for the contract works shall be based on the best current practice and in accordance with the latest editions of the following :

1. Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers (17th Edition) and associated guidance notes. BS 7671.
2. British Standard Codes of Practice.
3. British Standard Specifications.
4. British Standard 5306 Part 2 & Loss Prevention Council (LPC) Rules for Sprinklers.
5. Local Authority Bye Laws and Building Regulations.
6. CIBSE Current Codes of Practice and Design Guides.
7. CIBSE Energy Codes.
8. CIBSE Commissioning Codes.
9. CIBSE Code For Interior Lighting.
10. CIBSE Technical Memoranda.
11. CIBSE Lighting Guide LG6 : 1992 - The Outdoor Environment.
12. The Electricity (Factories Act) Special Regulations.
13. Electricity Supply Regulations and Electrical (Factories Act) Special Regulations.
14. Health and Safety At Work Act/COSHH Regulations.
15. British Gas Regulations and Recommendations.
16. All Enforcing Authority Requirements.
17. Water Board Requirements and Recommendations and Bye Laws.
18. Electricity Board Requirements and Recommendations.
19. British Approval Service for Electrical Cables.
20. The Licensing Justices Requirements.
21. The Disabled Authorities for facilities for the disabled.
22. CIBSE Code: Areas for Visual Display Terminals.
23. Recommendations of the Employers Insurers (although it is acknowledged that at the time of submitting the tender the Contractor has not had any discussions with the Insurers).



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24. CDM Regulations.
25. Any other Statutory requirement.

The quality of workmanship shall be in accordance with Part C of this Specification and relevant British Standards, and generally follow a good working Code of Practice.

The criteria for the design are detailed in the specification. The tender submitted shall provide for these criteria and the successful tenderer shall demonstrate as the installation work proceeds, and on completion, that the design intent, based on these design details has been achieved.

All testing instruments etc., required to demonstrate a satisfactory design and installation shall be supplied by the tenderer and included in the tender sum. All test instruments shall have a certificate of calibration and instruments shall not be used where more than 6 months have elapsed since the date of calibration.

All costs incurred by the tenderer in the preparation of the tender documents including the preparation of all drawings, printing etc., shall be borne by the tenderer.

The Employers Agent does not bind himself to accept the lowest or any tender.

All necessary scaffolding and access equipment for the installations covered by this specification shall be included in the tender.

5. CO-ORDINATION

The Contractor shall undertake to carry out all co-ordination of the Services Installations with the building fabric and other specialist services installations. This co-ordination shall take the form of:-

- i. Holding regular services co-ordination meetings.
- ii. Issuing working drawings, through to the various specialist Sub-Contractors for comment, and amending the services working details in accordance with the reasonable requirements of the specialist Sub-Contractors. Drawings shall be issued in good time for comments and revisions to be made.
- iii. Checking the Specialist Sub-Contractors proposals and building details to ensure that these will not compromise the satisfactory operation of this section of the works. N.B. It is emphasised that it is the responsibility of the Contractor to ensure that no aspect of the building form or other specialist sub-contracts prevents the satisfactory installation and operation of the Services installation.



6. STRUCTURAL LIMITATIONS

The Contractor shall be fully responsible for ensuring that the services installation is fully compatible with the structural design and detail, and that all necessary liaison takes place to ensure that the relevant building details (e.g., fixings, structural adequacy to support plant and equipment, openings, head-rooms, plant room sizes etc) are compatible with the proposed services solutions. During the tender, the Contractor shall provide the specialist sub-contractor with all constructional details, considered necessary to ensure that this requirement is met. Claims due to lack of information at time of tender stage will not be considered.



PART B - PRELIMINARIES & GENERAL SPECIFICATION

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PART B - PRELIMINARIES & GENERAL SPECIFICATION

B1 WORK INCLUDED

All materials specified in this Specification or indicated on the drawings shall be supplied, delivered, off-loaded, installed, tested and commissioned. The specification shall be read in conjunction with the drawings provided and given in the Schedule included in this Specification and in conjunction with the Engineering Services Bills of Quantities when these are provided. Whilst undertaking the works it is essential that the duty of 'care' is maintained.

Any items of plant and equipment shown on the drawings but not described in the specification, or described in the specification but not shown on the drawings, shall be provided as part of this section of the works, and be deemed to be included in the Contract price.

If there is a difference between the requirements of the Specification and the drawings, the difference shall be clarified before tendering and ordering.

Where 'shall' is used to give instructions in respect of a part of this section of the works, all costs arising from such instructions shall be deemed to be included within the Contract price.

B2 INFORMATION BEFORE TENDERING

Since the tender drawings are only representative of the work to be undertaken, they do not fully indicate every change of direction, bend, or offset, required in the services for their complete installation, and co-ordination with other services and the building structure. It shall be deemed that all aspects of the works have been examined and this Section of the Works shall include for all labour and materials necessary to achieve a full and co-ordinated installation of the work covered by this specification.

It shall be deemed that the site, the Conditions of Contract, Specification, Schedules, Associated Architectural and Structural Drawings and Plans have been examined. If all the particulars required cannot be obtained from this examination, application to the Services Engineer for further information shall be made.

Any claims because of want of knowledge in respect of the section of the Works included in this Specification will not be considered.

B3 SITE INSPECTION

It is advised that a site visit be made prior to submitting a tender, to determine the nature and location of the site, means of access, availability of space for huts and storage and existing services as no claim will be considered on the grounds of ignorance of conditions under which the Works will be constructed. Before making the visit prior approval **MUST** be obtained.

The tenderers shall be deemed to have satisfied himself with regard to access to the site, the various working heights, the extent and nature of the scaffolding, protective sheeting or boarding, if required, and generally the conditions under which the work will be required to be carried out, and to have obtained all information on all matters affecting the execution of the work.



B4 MATERIALS, DESIGNS AND INSTALLATIONS

Unless otherwise specified and approved all materials and designs, shall comply with the current issue of the relevant British/European Standard Specification and/or part thereof as appropriate, and their installation shall comply with the relevant current British/European Standard Code of Practice and/or part thereof as appropriate.

Materials, designs and installations shall comply with the current Health and Safety at Work Act, the British Communications Act, Factories Act, Home Office Regulations, Building Regulations, Local Authority Regulations and Byelaws, The Gas Safety (Installation & Use) Regulations, Requirements for Electrical Installations (BS 7671/IEE Wiring Regulations), Water Board Regulations, Insurance Company requirements, Fire Precautions Workplace Regulations, The Provision and Use of Work Equipment Regulations, The Lifting Operations and Lifting Equipment Regulations and other statutory Rules and Regulations as applicable.

Products shall display the British Standard, Kitemark or CE marking where applicable.

B5 SUPPLIERS

When materials or goods are specified as being technically in accordance with a particular quotation of a named supplier or specialist, quotations and conditions of sale or contract shall be obtained from that supplier or specialist.

This section of the Works shall include the responsibility for all dealings with and instructions to such suppliers or specialist and all others whether or not they are named in this Specification and for ensuring that their liabilities under the terms of this Specification are covered.

B6 MATERIALS SPECIFIED

Materials to be supplied by a specified manufacturer as detailed in this Specification or drawings or Engineering Bills of Quantities are a standard of quality.

Tenders shall be based on the materials specified and the manufacturers named in this Specification not those considered equal. Tenders not submitted in accordance with this requirement shall be deemed invalid.

Alternatives may be submitted either after Contracts or Sub-Contracts are placed or may accompany the tender according to the requirements of the particular Contractor or Sub-Contractor.

The Contractor/Sub-Contractor shall clearly demonstrate and accept full responsibility for ensuring the suggested alternative is equal in standard and quality and all other respects to the specified materials and product.

Agreement to use such alternatives shall be obtained before they are used. Any costs incurred by the Client and/or a member of the design team in assessing the suitability of any proposed alternative, shall be borne by the Contractor/Sub-Contractor whether or not those alternatives are ultimately accepted or not.

The Contractor/Sub-Contractors shall be responsible for any technical or cost implications to other services and trades that may result from the acceptance of any alternative to the specified product, components, material or working procedures, including costs incurred by the Engineer/Design Team.



B7 DESIGN RESPONSIBILITY OF PLANT AND EQUIPMENT

Where items of plant or equipment are specified to be supplied by a particular supplier, manufacturer or Sub-contractor and the equipment is also designed by the particular supplier, manufacturer or Sub-Contractor specified, this section of the works shall include the responsibility for the design.

In addition, the design responsibilities for plant, equipment and systems shall be included, where such are specifically designed for the works. Where the form of contract incorporates a Contractor's designed portion supplement, the terms of the supplement shall apply to all such plant, equipment, and systems.

B8 MATERIALS TO BE USED

All materials supplied shall be of a type that will not support bacteria. No acoustic insulation or sound deadening materials shall be manufactured with any form of animal hair.

Deleterious materials shall not be utilised on any part of these Works. Deleterious materials include materials containing fibres of less than 3 microns diameter or less than 200 microns long, or which contain any fibres not sealed or otherwise stabilised to ensure that fibre migration is prevented, asbestos or asbestos products, and urea formaldehyde, but this is not an exhaustive list.

All jointing materials shall be of a type approved by the Water Research Centre.

B9 NOTICES AND FEES

All notices required by any Act of Parliament, or Building Regulations or by any Byelaws, Rules or Regulations of any Authority who has any jurisdiction with regard to the Works or with whose systems the works are or will be connected shall be given and any fees or charges (including any rates or taxes) legally demandable under such Act of Parliament, Building Regulations, Byelaws, Rules or Regulations shall be paid, and included in the Tender submitted.

Where the requirements of any Gas, Water or Electricity Authority call for the submission to them of any component part of the Works for approval, testing, stamping or certifying, such parts shall be submitted to the place required by such Authority and shall after testing, approval, stamping and certification, be returned to the site for incorporation in the Works.

B10 TYPE OR MODEL

Where specific type or model numbers for plant items or equipment are given in the technical schedules which do not incorporate all the requirements specified in Part C of the Specification, then these requirements shall be included in the tender, unless these requirements are specifically deleted in the Schedules.

B11 EQUIPMENT SELECTION

Whether or not specified in each section of this specification, all equipment i.e. fans and pumps, and the like shall be selected to ensure that the specified duty is not on or close to, or at the top or close to the top of, a particular performance curve.

Each installed piece of equipment shall have a body and impeller which is capable of handling an increase in pressure which is a minimum of 15% above the specified total pressure at the design volume.



The motor of each installed piece of equipment shall have a size/rating which is a minimum of 15% greater than that required for the selected unit body and impeller.

B12 BELT DRIVEN EQUIPMENT

Where belt driven equipment is specified, an allowance shall be made for changing the belts and pulleys of each piece of equipment once, to enable the design quantities to be obtained.

This is in addition to the provision of motors sized 15% above that required for the actual duty.

B13 MANUFACTURER'S RECOMMENDATIONS

Products shall be handled, stored and installed in accordance with the manufacturer's recommendations. Any conflict with other specified requirements shall be reported. Copies of the manufacturer's recommendations shall be submitted when requested.

B14 SAMPLES

Where approval of products or materials is specified, samples shall be submitted or other evidence of suitability shall be provided. Orders shall not be confirmed or materials used until approval has been obtained. Approved samples shall be retained on site for comparison with products or materials used, and be removed when no longer required.

Where samples of finished work are specified approval of stated characteristic(s) shall be obtained before proceeding. These approved samples shall be retained on site for comparison with the finished work. Samples shall be removed when no longer required.

B15 EXAMINATION OF DRAWINGS & INFORMATION PROVIDED

The Contract Drawings and Specification shall not be varied in any way unless agreed in writing.

Where the Specification indicates that examination of the details of any item is required before the work is undertaken, adequate time must be allowed for this to be carried out.

Where alternatives are given in the Specification, agreement to utilise these shall be obtained before work is commenced.

Examination of drawings or other information will not relieve the Contractor/Sub-Contractor of his responsibilities for discrepancies, errors or omissions in the drawings he produces, provided that such discrepancies, errors or omissions are not due to inaccurate information or particulars furnished to him in accordance with the Conditions of Contract.

B16 BUILDER'S WORK

Builder's Work drawings covering the whole of the requirements for this Section of the Works shall be provided on the immediate commencement of the Works. The drawings shall detail work that forms part of the building construction and shall include concrete bases, the building in of steelwork, foundation bolts and metal inserts, making chases and cutting away and making good and the like. The builder's work drawings must indicate accurately the sizes and positions of all items of builder's work required. Alternatively, a request may be made to mark out in advance on site the builder's work requirements.



Any builder's work requirements for the engineering installation shown on the structural engineering drawings shall be checked as part of this Section of the Works, to ensure that they meet the full requirements.

Where possible, the depth of wall chases shall be equal to the external diameter of the conduits to be installed to allow the plaster cover to be of normal thickness.

Where chases are to be pre-cast detailed drawings shall be prepared and submitted through the Services Engineer to the Contractor.

Drilling plug holes in floors, walls, ceilings and roofs for securing services and equipment requiring screw or bolt fixings shall form part of this Section of the Works. Plastic or metal plugs only shall be used. Permission shall be obtained for all fixings into concrete walls, floors, ceilings and roofs.

Lightweight equipment and pipework may be fixed to the building structure by screws in fibre, plastic or metal plugs. Wood plugs shall not be used. Fixings to brickwork, blockwork and pre-cast concrete components shall not be made in the bond. Fixings to wood fitments shall be by screws. All screw fixings shall be BZP and greased before use.

Heavyweight equipment and pipework shall be fixed with masonry fixings of the expanding type equal to Rawlplug "Rawlock" or "Thresbolt" or alternatively "Liebig Safety Bolt". Fixings to concrete shall not exceed 30mm in depth and 6mm in diameter without the written consent of the Architect.

Fixings shall be of the correct size and type for the fixing load applied and the type shall be agreed with the Services Engineer in writing prior to the commencement of the works.

Where shot fixing into structural elements, drilling or cutting of structural steelwork is required to be included in this section of the Works, then special application in writing, with sketch drawings, must be made and agreement received in writing before any structural steelwork is cut or drilled. Fixings to steelwork shall be of the clamp type and no steelwork shall be cut, drilled or welded, except where specified otherwise.

For external pipework and cabling installations the Contractor shall excavate trenches, construct chambers for valves, hydrants and the like, form thrust blocks, supply and lay cable, pipes and on completion of the engineering installation work, shall backfill and reinstate the ground and include for appropriate marker tape along runs and at changes of direction.

B17 DRAWINGS

The tender drawings as listed in this document are representative of the work to be carried out and when read in conjunction with the Specification provide information for tendering purposes.

Two copies of the Tender drawings and Specification shall be provided at the commencement of the Contract stage and any subsequent amendments will be dealt with in a similar manner.

This Section of the Works shall include the responsibility for providing the installation drawings necessary for the construction of the whole of the works covered by this Specification, together with the additional drawings listed in the Schedule of Drawings contained elsewhere within the Specification. The cost of preparing the drawings and supplying six paper copies of each drawing shall be included in the Tender.

All installation drawings shall be provided in good time to meet the agreed programme for the Works.

Apart from those drawings which must be issued for construction purposes before the Contract is let, drawings of builder's work, in accordance with the Clause 'Builder's Work', wiring diagrams, and



drawings of work to be done by other trades required for the purposes of the complete installation, shall be provided as part of this Section of the Works.

This Section of the Works shall include the responsibility for any discrepancies, errors or omissions in the drawings and any other particulars supplied, provided that such discrepancies, errors or omissions be not due to inaccurate information or particulars furnished in writing in accordance with the Conditions of the Contract.

The use of the base services layout drawings prepared by the Services Engineer will be permitted to enable the drawings required by this section of the works to be prepared. These base services layout drawings will not be provided free of charge, and all costs associated with their provision, shall be agreed with the Services Engineer prior to their production. The Services Engineer will not, under any circumstances, accept any responsibility for any discrepancies, errors or omissions in any of the base drawings provided by him.

B18 SCHEDULE OF RATES

Prior to, and as a condition for acceptance of the tender, three copies of a Schedule of Quantities and Rates upon which the tender is based shall be submitted to the Services Engineer. The Schedule shall be forwarded to ensure it reaches the Services Engineer within seven days of being requested to do so.

The Schedule shall fully detail quantities and rates for all works in accordance with the Standard Method of Measurement current edition, authorised by agreement between the Royal Institution of Chartered Surveyors and the Building Employers Confederation.

The Schedule shall be fully priced and broken down to reflect the various sections of work included in the Summary of Tender. The total price of each section of the Schedule shall equate to the price included for that particular section of work indicated in the Summary of Tender. The total of the various sections of the Schedule shall equate to the original Tender price. It shall be used only for the pricing of variations.

In the event of any discrepancy in the Schedule, the quantities and/or rates shall be corrected as necessary but the total sum shall not be amended as a result.

Where it is necessary to agree a rate for an item that is not included in the Schedule of Quantities & Rates, this shall be calculated in a manner similar to comparable items. All additional rates shall be calculated using prices applicable at date of tender. Where applicable, price fluctuation will be valued in accordance with the Conditions of Contract.

It should be noted that the Tender Drawings are diagrammatic only and do not indicate the full extent of fittings and labours which will be required and which are measurable under the S.M.M. No additional payments will be made for works executed in a more complex manner than can be reasonably envisaged from the Tender Documentation and information available to the Sub-Contractor at Tender Stage. Similarly, if additional works are authorised, these will be valued in accordance with the items and rates included in the Schedule of Quantities, irrespective of whether more complex fittings and labours are actually required, unless it can be shown to the satisfaction of the Services Engineer that the additional work is significantly more complex than the general level of complexity of installations on this project.

B19 INTERIM APPLICATIONS



Interim applications shall be submitted seven days before the date when an application is to be made for an interim payment, showing itemised breakdowns of the total values only of work done and unfixed materials on site. Applications shall only include goods or materials owned by the applicant, and this shall be confirmed on each interim application submitted. Interim applications not confirming titlement of goods will not be certified.

Where fluctuations are allowed under this Contract these shall be included in a separate document and submitted monthly with the interim application. The document shall provide all supporting information including time sheets signed by the Clerk of Works, suppliers invoices, price lists, index calculations, as applicable.

B20 INSTRUCTIONS AND VARIATIONS

No variation shall be undertaken without written authorisation. The price of each authorised variation shall be submitted within seven days of such authorisation or on the completion of the variation when carried out as daywork.

When materials and equipment which are not included in the Schedule of Rates are required to be provided under a variation, included with the estimate for the variation shall be a copy of any quotation received from suppliers and shall show separately the allowance required for overheads and profit. If a price list is used in place of a quotation the date and reference of the price list shall be stated.

Should it be considered that the regular progress of the Works or of any part thereof has been or is likely to be so materially affected by the variation, written notice shall be given?

B21 DAYWORK

No work shall be undertaken at daywork rates without written approval.

Daywork sheets shall be signed at the time by the Clerk of Works or other approved personnel and submitted in triplicate with detailed schedules supporting the claim at the end of the week following that in which the work has been executed. The signing of daywork sheets by the Clerk of Works or other person shall not of itself constitute authorisation of the work.

The cost of authorised daywork will be calculated in accordance with the appropriate 'Definition of Prime Costs of Daywork' issued by the R.I.C.S. and the B.E.C., H.V.C.A., E.C.A. & E.C.A. (Scotland), together with percentage additions. The percentage additions included in the Contract documents are for overheads and profit and also for all items defined in Section 6 of the aforementioned document.

The labour base rates which will be allowed will be those which were applicable at the time of tender. Where applicable, cost fluctuations will be valued in accordance with the Conditions of Contract. They will be calculated using Union Rates in accordance with the Definitions strictly nett.

B22 OVERTIME

Only when a specific instruction is given in writing shall the extra costs incurred in respect of overtime be included in the final account.

No addition for profit or establishment charges based on extra costs of overtime shall be made in the final account but where appropriate the 2.5% cash discount allowable to a Contractor shall be included.



All claims under this clause shall be submitted weekly for approval.

B23 FINAL ACCOUNT

The final account shall be delivered as soon as possible after the beginning of the Defects Liability Period.

No accounts shall be authorised that are received after the expiration of 6 months from the date stated in the Certificate of Practical Completion of the Works unless otherwise stated.

The final account shall only include the Sub-Contract or Contract sum as applicable less any P.C., P.S. or Contingency Sums where applicable but including all variations and instructions agreed during the construction of the Works and confirmed in writing. Where fluctuations are allowed under this Contract these will have been agreed monthly with the interim claims (see Interim Claims) and shall be listed separately.

Only those items listed above will be allowed in the final account.

B24 EQUIPMENT

All service connections shall conform with the items of equipment to which connections are to be made.

Technical co-ordination shall be carried out to ensure the safe and correct operation during disconnection and reconnection relating to items moved or repositioned during the works.

Details of operation, working pressures and temperature of equipment shall be checked and written confirmation obtained from the manufacturers before any service is first operated.

B25 INTERCHANGE ABILITY

Where equipment and layout permit, parts of items of plant, pipework connections, and the like shall be interchangeable with corresponding parts, connections, and the like in similar items of plant.

B26 FOUNDATION BOLTS AND ALIGNMENT

Foundation bolts shall be resin type anchors and shall be supplied for each item of equipment fixed to a concrete type floor or base. They shall be of the straight shank type and correct diameter and length, threaded at each end and unless otherwise specified shall be provided with a nut and a square mild steel holding down plate at the lower end and an approved type of self-securing lock-nut at the upper end. The foundation bolts shall be carefully positioned and grouted-in to the floor or base and each item of equipment shall be aligned and levelled using steel shims.

B27 INSTALLATION LIAISON

The Contractor is responsible for the co-ordination of all his Sub-Contractors and their installation work on site. All Sub-Contractors concerned with the Works will be required to co-operate with the Contractor and others before the work is commenced and to ensure the correct design intent during the course of construction. This shall include all necessary liaison with the Contractor and all other Sub-Contractors prior to the preparation of the installation drawings, to ensure that the final detailed installation drawing layouts prepared under this section of the works are compatible with all others aspects of the works i.e., structure, and other services, being installed in the same vicinity. Any work



which has to be re-done due to negligence in this respect will not constitute an extra. Particular care shall be taken to prevent obstruction of electrical service positions, cable routes, switch positions, access positions and obstruction of sanitary engineering services, rodding positions, and the like. Services installed in ducts shall be so arranged to permit maximum access along the ducts and all services, equipment and plant shall be readily accessible for maintenance.

All plant, equipment, and the like are shown in approximate positions on the tender drawings. Their exact location shall be determined from the installation drawings or by consultation on site.

Where the work includes the installation of large items of equipment such as tanks, cylinders, ductwork, transformers, switchgear or long lengths of pipe or cable, the access required shall be arranged in good time.

Particular care shall be taken to obtain uniform and tidy arrangements of wall and ceiling mounted equipment. The precise position of a piece of equipment shall be determined as follows, unless otherwise shown on the drawings:-

- (1) Single items of equipment which are visually remote from other electrical or mechanical equipment shall be erected at the mounting height stated in the general Specification or on the drawings.
- (2) Two or more items of equipment, whether electrical or mechanical or both, which are to be erected on the same wall or ceiling, or which will be otherwise visually close to each other, shall be arranged in a neat and symmetrical group. Symmetry of arrangement shall be obtained by horizontal and vertical alignment through the centre lines and not the edges of the equipment, and for this purpose the mounting heights stated in the general Specification or on the drawings may be varied slightly.

All concerned will be required to co-operate in planning these arrangements.

B28 OFF-LOADING AND INSTALLATION

The supply, delivery, off-loading, positioning and installation of all equipment and materials detailed in this Specification and indicated on the drawings shall form part of this section of the Works.

This shall include the provision of all necessary craneage, hard standing for same, lifting tackle, trolleys, skids, tools, ladders, temporary workshops, gangways, fences, scaffolding other than that already erected, and the like and the subsequent removal.

Timely indication shall be given of any difficulties likely to be encountered in accommodating plant or equipment in the spaces available.

The strength of floors across which heavy loads are to be moved shall be checked in good time before the load is applied so that if the strength of any floor is found to be inadequate, arrangements for supporting the load can be made without delaying its movement.

Plant and materials shall not be deposited on roadways or footpaths, in corridors or rooms unless prior permission has been obtained in writing.

This section of the Works shall include the responsibility for any damage caused by the off-loading and movement of this material.

B29 DELIVERY AND CONSTRUCTION PROGRAMME

A comprehensive and detailed delivery and construction programme shall be prepared at the earliest possible date, as a requirement of this section of the works.



The programme shall be of the simple bar chart type, suitably broken down into services elements covering each main area or floor level, indicating dates for the commencement and completion of all sections of work and the content of the programme shall be agreed with the Services Engineer before preparation commences.

The programme shall make an allowance for, and indicate separately, all work including preparation of drawings, comments on drawings, first fix items, second fix items, pre-commissioning checks, pressure testing, setting systems to work, commissioning and performance testing, witnessing of tests by the Services Engineer, and demonstration of plant and equipment. The programme shall clearly indicate what are considered to be first and second fix items, and also show the required delivery dates of all goods and materials vital to the programme. Evidence shall be provided that such goods and materials can be made available at the required time.

Whilst long delivery items must be ordered early, care must be taken to ensure that items, which may deteriorate under site conditions, are not delivered to site too early (even if there should be slippage in the Construction Programme). Such items, if ready for delivery too early, must be warehoused at the Contractors/Sub Contractors cost.

The programme shall also show:-

1. The periods allowed for the proving and setting of work of plant and equipment.
2. The periods allowed for diversion and/or re-provision and/or special protection of existing services which are affected by the new construction. In particular, any such work which has to be carried out in advance to enable the Contractor to begin work, must be clearly shown.
3. Projected dates for breaking-in to existing services. In arriving at these dates the particular operating conditions of the service concerned shall be borne in mind (i.e., whether it operates 24 hours/day, 7 days/week or only weekday office hours; whether it operates only through the winter months and is shut-off through the summer months; or whether there are specific peak demand/loading times), and programme break-ins organised to minimise disruption.

It should be noted that the Services Engineer shall only witness performance tests when all elements of building works have been completed, and due allowance for this shall be made when the programme is being prepared.

Should the agreed programme for the works require to be modified, a revised programme covering this section of the works shall be prepared and issued.

B30 SUPERVISION OF LABOUR

A qualified representative shall constantly be kept upon the Works with a thorough experience of the class of work covered by the Specification. So far as possible, this representative shall not be changed during the course of the Works.

Trade custom in the employment of the appropriate grades of work people shall be followed.

Work people shall not trespass beyond the limits of their work.

B31 PROTECTION OF MATERIALS AND WORK

The following shall be provided, during storage and installation.



Adequate and safe storage for all material, plant and equipment necessary for the Engineering Services works, including suitable protection against the weather, and ingress of dirt or moisture into working parts.

Purpose made racks for storage of conduits, pipes and similar materials to prevent bending and distortion, and to support them clear of the ground.

Purpose made end caps to protect pipes, threads, nozzles and support system.

Protection by means of paint, tallow or grease for bright and machined surfaces, which immediately before handover shall be cleaned and polished.

Precautions and protection against frost, building works, or operations by others, including mechanical damage by other trades.

Suitable racks and storage for plant, equipment, pipework and other materials unable to be stored in huts or buildings.

Protection for electrical cables and seal cable ends using methods and materials recommended by cable manufacturers.

Leaving plant and equipment in a condition ready for finish painting where specified as part of the work or by others.

Painting of parts liable to corrosion immediately after removal of temporary protection.

Replacement material, plant or equipment where deterioration or damage has occurred prior to handover.

Personal protective equipment is to be used only as the last resort, risks should always be 'designed out'/ reduced where possible/practicable.

B32 ELECTROLYTIC ACTION

At all connections between copper pipework and ferrous pipework or equipment, insulating material in the form of non-metallic fittings or joint rings, shall be incorporated in order to prevent direct contact between the two metals and the setting up of electrolytic action.

B33 DEZINCIFICATION

All plant pipework, fittings and brazing materials used shall be made from non-dezincifiable materials whether specified in particular detail or not.

B34 WELDING OF STEEL & BRAZING OF COPPER PIPE LINES

Welding of steel pipework shall be by Oxy-acetylene or Metal Arc. All steel pipes of 125mm bore and above shall be welded by metal arc. Where metal arc welding is employed on site, all steel flanges irrespective of size shall be so welded.



Welding and brazing shall be executed by operatives who hold an appropriate Certificate of Competency as issued by the National Joint Industrial Council of the Heating, Ventilating & Domestic Engineering Industry, British Oxygen Company, Lloyds or the Associated Offices Technical Committee. Operatives shall only perform the type of welding or brazing (oxyacetylene or metal arc) defined in their Certificate of Competency.

Brazing shall be carried out in accordance with BS 1723 and Technical Note TN4 issued by the Copper Development Association. Filler metal shall be a zinc free alloy to BS 1845, Group CPI and the flux shall be as recommended by the filler metal manufacturer. On completion, all flux and filler metal shall be removed.

Welding shall be carried out to HVCA Code of Practice TR/5 Welding of Carbon Steel Pipework and to BS 2640 and BS 2971.

The names of such operatives and their appropriate Certificate shall be submitted to the Services Engineer for approval before any work is executed on site. The Certificate shall be returned after inspection.

Each operative having completed a joint shall stamp the number of his Certificate of Competency on the pipe adjacent to the joint. Any work which is found to have been performed by an operative whose name has not been previously approved shall be removed and the pipelines re-made by an approved operative at no extra charge.

Any operative may be site tested by welding executed in situ then cut for examination, mechanical and metallurgical testing.

All work shall be carried out in accordance with 'Welding of Carbon Steel Pipework' and 'Brazing and Bronze Welding of Copper Pipework and Sheet' issued by the Heating and Ventilating Contractors Association.

Purpose made welding fittings to BS 1965: Part 1 shall always be used.

All arc welding plant shall be provided, wiring and equipment complying with DD CLCITS 62081 and BS EN 60974.

Diesel generators may be used or, alternatively, rotary converters and transformers. Arrangements must be made for the primary electrical supply and the payment of all electricity amounts concerned with the welding equipment. It must not be assumed that an electrical supply for arc welding will be available unless specifically stated.

Unless otherwise indicated welds in each and every system shall be subjected to a programme of non-destructive radiographic testing in accordance with BS 3923. All testing shall be carried out by a certified competent person, recognised by the appointed Inspection Body. Copies of each test report shall be issued to the appointed Inspection Body and the Services Engineer at times which permit adequate consideration whilst welds remain exposed.

The non destructive testing programme shall include for :-

1. On completion of the first ten production welds made by each operative on each size of pipe, one of the welds in each size of pipe shall be tested.
2. Testing of 10% of the subsequent production welds made by each operative, randomly selected by the Services Engineer.

If any test specimen is unsatisfactory, two further joint specimens of the relevant operative shall be selected from the production joints and subjected to re-tests. In the event of failure of any of the re-



test specimens, the production joints carried out by this operative subsequent to the previous tests shall be replaced in an approved manner, at the cost of this Section of the Works.

Welds found to be defective shall be rectified to a standard complying with BS Class II specifications to the satisfaction of the appointed Inspection Body. At the discretion of the Services Engineer, rectification work shall be carried out by different welders. At the Services Engineers discretion, welders with failure rates considered excessive by the appointed Inspection Body shall be taken off the works.

B35 ELECTRICAL COMPETENCY

Electrical installation works shall only be undertaken by operatives who hold an appropriate Electro-technical Certification scheme card issued by the Joint Industry Board (JIB) or equivalent body.

Copies of the above cards shall be forwarded a minimum of 48 hours prior to commencement of the operative on site.

Operatives who do not have the appropriate card or whose card has not been submitted will be asked to leave site. The Contractor shall have no recourse in this respect.

Site operatives with 'Apprentice' and 'Electrician' certification cards will be acceptable on site where adequate supervision is afforded by an operative with 'Approved' status or above.

The minimum level of operative certification on site shall be 'Approved'.

B36 ELECTRICAL CONTINUITY

Metal pipework, metal cladding to insulation, and ductwork systems shall be erected and installed to ensure electrical continuity throughout.

The means of continuity at joints and flanges shall be provided by metal to metal contact and shall be robust, permanent, effective and compatible. Continuity across final flexible ductwork connections to diffusers and ceiling grilles shall be by means of 4mm² earth bonding conductors in accordance with the current Edition of BS 7671.

The manufacturers of equipment such as air handling units shall ensure electrical continuity across non-metal flexible connections between components by means of flexible earth bonding conductors sized in accordance with the current Edition of BS 7671.

Surfaces of connections in contact with aluminium or galvanised steel shall be tinned or otherwise electrolytically compatible.

In support of R W Gregory LLP Environmental (accreditation) Policy to BS EN ISO 14001, preference shall be given to Contractors and Manufacturers that can demonstrate their awareness and commitment to environmental matters.

Where a choice exists, equipment and materials shall be those that are environmentally benign and naturally sustainable.

B37 SLEEVE PIPES AND COVER PLATES

Except where indicated on the drawings as being built into the structure, each pipe passing through a wall, floor or ceiling shall be provided with a sleeve pipe with the internal bore exceeding the diameter of the pipe passing through by not less than 5mm.



Where the pipe is insulated the sleeve shall be 5mm in excess of the overall diameter i.e. on chilled water systems the insulation shall be continuous through the wall, floor or ceiling.

Greater clearance may be required where expansion requirements render it necessary and in such positions each sleeve shall be fitted off-centre with the greater clearance on the side of the pipe toward which expansion will move.

Sleeve pipes shall finish flush with the walls, floors and ceilings except in areas which may be subject to washing down, where sleeves shall protrude 100mm above finished floor level.

Sleeve pipes for steel pipework shall be constructed from mild steel pipe or cast iron pipe as detailed later.

Sleeve pipes for copper pipework shall be constructed from copper pipe or brass pipe as detailed. Split floor plates shall be mild steel chromium plated.

Pipe sleeves and floor plates shall be installed as follows:-

Plaster Ceiling	Flanges on the top side and split floor plates of the set screw Pattern to the underside.
Structural Walls and screw Floors	Mild Steel/Copper/Brass with split floor plates of the set pattern to each side.
Pipes above Ceilings	Cast Iron / Mild Steel / Copper / Brass piping and below Floors
Pipe bends in solid Floors or Walls	suitably wrapped and finished with split floor plates Of the set screw pattern to each side.

If installed in ventilated pressurised areas pipe sleeves shall be packed with glass fibre cord to form a seal.

B38 FIRE AND SMOKE STOP BARRIERS

Where cables, conduits, trunking, pipework or ductwork, pass through fire or smoke stop barriers, such as walls or floors so designated on the Architectural and Structural drawings or drawings forming a part of this section of the works, the opening shall be permanently sealed to maintain the integrity of the compartment barrier, in compliance with the Building Regulations Approved document B Section B.3 10.6, using products tested in accordance with BS 476 20 and 22. All products shall be suitable for the temperature of the service on which they are being used.

Where cables, pipes or trunking are installed inside channel ducts or sleeves which pass through fire or smoke stop barriers, internal barriers shall be provided, equal to rock wool materials or fire resisting compound to maintain the integrity of the compartment barrier.

Ventilation ducts passing through fire or smoke stop barriers shall be fitted with dampers as allowed for in the design.

PVC pipework of internal dimensions greater than 38mm shall not pass through a fire or smoke stop barrier unless it is protected to comply with BS 5588 : Part 9 and BS 8313.



Where cables, conduit, trunking, pipework or ductwork pass through a builder's opening without a specified fire or smoke requirement, then the opening shall be sealed by Rockwool material or similar approved.

B39 HEALTH AND SAFETY

All work undertaken and completed as part of this section of the works shall be carried out fully in compliance with the Construction (Design and Management) Regulations 1994 (CDM). Full assistance and co-operation shall be given to The Principal Contractor to ensure complete and accurate Health & Safety documentation is provided throughout the course of the contract and ultimately at completion of the works.

Notification shall be made in writing of the intention to use on site any equipment, liquids, gases or other articles or materials which may endanger life or property. It shall be ensured that safe methods of working are followed at all times. All necessary precautions shall be taken to safeguard against damage by fire or explosion where the execution of work may involve the presence of flame or sparks.

Petroleum products and other flammable or vaporising liquids shall only be used in accordance with the regulations applicable to the storage and use of these products.

When equipment and vessels which contain flammable liquids or gases are not in use they shall be removed together with any stored liquids or gas, to a safe place of storage.

Where the work involves the removal or possible contamination with asbestos materials due care shall be taken. The attention of everyone involved including the Health & Safety Executive shall be brought to the dangers of the work, and the Sub-Contractor shall be responsible for fully complying with the Asbestos Regulations and the current issue of the Approved Code of Practice & Guidance Note 'Working with Asbestos Insulation & Asbestos Coating' and the publications listed below. He shall also be responsible for arranging any tests, and for obtaining and following the advice of the Factory Inspectorate relating to the material handling and disposal.

Work involving asbestos materials shall be carried out in strict accordance with current legislation which includes the following publications:-

- (a) Health and Safety at Work No. 44 - Asbestos Health Precautions in Industry.
- (b) Health and Safety Commission - Asbestos Measurement and Monitoring of Asbestos in Air.
- (c) Technical Data Notes
 - H.M. Factory Inspectorate
 - Technical Data Note 24 - Asbestos Regulations, Respiratory Protection Equipment
 - Technical Data Note 35 - Control of Asbestos Dust
 - Technical Data Note 42 - Probable Asbestos Dust Concentrations at Construction Processes
- (d) Health and Safety Commission - Asbestos - Work on thermal and acoustic insulation and sprayers coatings.
- (e) Approved Code of Practice & Guidance Note Working with Asbestos Insulation & Asbestos Coatings.

Only specialist firms possessing a licence for working with asbestos insulation and asbestos Work Act and Asbestos Licensing Regulations will be permitted to undertake such work.

When any handling or removal work is complete a certificate shall be obtained from the specialist firm or from an independent testing specialist to confirm the space or area safe.



It shall be ensured that all safety and welfare measures required under or by virtue of any enactment or regulation on the working rules of the industry are strictly complied with and these shall include:-

- (i) The Factory Act
- (ii) The Health & Safety at Work Act
- (iii) The Public Health Act
- (iv) The Fire Precaution Act
- (v) The Clean Air Act
- (vi) The Offices, Shops & Railway Premises Act
- (vii) The Gas Act
- (viii) The Boiler Explosion Act
- (ix) The Control of Pollution Act
- (x) The Disposal of Dangerous Wastes Act
- (xi) The Explosion Act
- (xii) The Petroleum (Consolidation) Act
- (xiii) The Building Regulations
- (xiv) The Statutory Instruments :
 - No.1580 The Construction (General Provisions) Regulations
 - No.1581 the Construction (Lifting Operations) Regulations
 - No.690 the Construction (Working Places) Regulations
 - No.95 the Construction (Health & Welfare) Regulations
 - No.535 Factories Abrasive Wheels Regulations
 - No.690 Health & Safety Asbestos Regulations
 - No.1178 Gas Supply Regulations
 - No.723 the Building (First Amendment) Regulations
- (xv) The Electricity (Factory Act) Special Regulations
- (xvi) The Highly Flammable Liquids & Liquidified Petroleum Gas Regulations
- (xvii) The Safety Representatives & Safety Committee Regulations
- (xviii) The Dangerous Occurrences (Notification) Regulations
- (xix) The Code of Welfare Conditions for the Building Industry Approved by the National Joint Council of the Building Industry or any Regional Joint Committee thereof.
- (xx) Construction (Design & Management) Regulations 1994 (CDM).

B40 PERSONAL PROTECTIVE EQUIPMENT

The provision and wearing of safety helmets and safety footwear by all people on site shall be mandatory and strictly enforced under this section of the works. Other aspects of Personal Protective Equipment shall be assessed and provided as required, following the completion of the appropriate risk assessment.

B41 MACHINE GUARDS

Wire guards shall be fixed over the drives and moving parts of all machinery supplied. The guards shall be of substantial construction and shall comply with the requirements of the Factories Act and Health & Safety at Work Act. The guards shall be so constructed that the rotation of shafts and the movement of drive belts may be readily observed without removal of the guard, and the guard design shall comply with PD 5304.

All guards shall be removable and provision shall be made so that access can be obtained to the ends of the motors and shafts.

B42 INTERFERENCE SUPPRESSION



All equipment used for the erection of the works shall, where necessary, be fitted with suppressers to limit radio interference to the levels prescribed in BS EN 55014.

B43 ELECTRICAL APPARATUS AND SUPPLY

Low voltage distribution will be at 400 volts, 3-phase and/or 230 volts single-phase unless otherwise specified. All equipment covered by this Specification shall be suitable for use at these voltages and shall operate satisfactorily when the voltage at the terminals is reduced or increased by 10% and shall comply with BS 7671 and all other relevant parts of this Specification.

B44 TYPE OF CABLE AND CONDUCTOR

In general the precise types of cables to be used are specified on the drawings or in the schedules. If any cable is not precisely specified in any respect, the choice and construction shall be determined in accordance with the Section 521 of BS 7671 and the latest British Standard.

B45 COMPLIANCE OF ELECTRONIC/ELECTRICAL EQUIPMENT

All electronic/electrical equipment and software supplied under this section of the works shall be in accordance with BS PD 2000/1.

All equipment supplied under this section of the works shall comply with EU Regulations in the form of EMC Directive 89/336/EEC to ensure full electro-magnetic compliance.

B46 SEGREGATION OF SERVICES

Services shall be segregated in accordance with BS 7671.

Fire alarm warning and contact circuits other than those wired in MIMS cable shall not be drawn into the same conduit or duct compartment as any other circuit.

The metal sheaths and/or armour of all cables operating at a voltage exceeding extra-low voltages, and earth continuity conductors or metal conductors, ducts or trunking associated with such cables shall be prevented from coming into contact with other services by a spacing of 150mm.

Where it is impracticable to obtain this separation, the cable sheaths, armour, conduit, duct or trunking or other earth continuity conductors may be bonded to the exposed metal of the other system or service to the requirements of BS 7671.

Electrical services which run parallel with hot water or heating service pipes shall be run below them. No connection boxes shall be positioned below service pipes.

B47 NOISE AND DISTURBANCE

The use of noisy mechanical tools or equipment will only be permitted by prior arrangement. Should any request for such use be declined or specific instructions be issued that such noise cannot be accepted, this decision shall be accepted and alternative arrangements made at no additional contractual cost.

B48 DRYING OUT OF BUILDINGS



The Contractor is responsible for the adequate drying out of the buildings during the execution of the Contract and will allow for all costs in providing the necessary labour, appliances and fuel in order to comply with this requirement.

If the permanent heating installations are available, they may be operated for the purpose of drying out the buildings. The Contractor will be required to provide all necessary electric current, water, attendance, maintenance and to effect any additional insurance required and pay the premium thereof. If the permanent heating installations are operated the provision of fuel will be the responsibility of the Contractor.

The Contractor shall be responsible for arranging adequate supervision, attendance and maintenance of the plant and equipment, together with payment of any additional insurance premiums required for this purpose, prior to take over of the building.

Before the heating installations are offered for handover any part that has deteriorated or its working life significantly reduced shall be replaced.

The Defects Liability Period will commence from the date of the hand over certificate and not the date when the installations are brought into use for any other purposes.

B49 TEMPORARY LIGHTING

The Contractor is responsible for providing adequate temporary lighting for the execution of the Contract.

If the permanent lighting installations are available they may be used for the purposes of temporary lighting provided that the diffusers are not installed and the lamps used for temporary lighting are replaced prior to handover.

All lamps used for temporary lighting shall be marked before installation.

The defects liability period shall commence from the date of the Handover Certificate and not the date when the installations are brought into use for any other purpose.

B50 FUEL FOR TESTING

The cost of any fuel, energy and water required for use during the filling, flushing, testing and commissioning of the installations shall be included in this section of the works.

B51 PAINTING

All work shall be generally in accordance with the relevant sections of BS 6150, as applicable. All paints utilised, including primer, shall be lead free.

Unless otherwise specified the whole of the engineering services, equipment, pipework, brackets, supporting steelwork, hangers, and the like shall be painted in an approved manner. Colours for brackets supporting pipework, and the like shall match the colour of the material to which they are attached.

Before any painting of conduit or ironwork is commenced it shall be thoroughly cleaned so as to be free from scale, rust, oil, and the like.

All exposed galvanised mild steel supplied as part of this section of the Works shall be prepared for painting and first given one coat of calcium plumbate primer containing not less than 73% of calcium



plumbate in the pigment, and finished as detailed below. The pigment binder ratio shall not be less than 2/1.

Supporting metal for the engineering services must be delivered to site in a rust free condition, painted with zinc phosphate primer and finished as detailed below.

Any supporting metalwork fabricated on site shall be thoroughly cleaned, including wire brushing to remove all rust and shall be free from mill scale, oil and the like and first painted with zinc rich primer before being finished as detailed below.

Unless otherwise specified the whole of the engineering installations, all equipment, except as mentioned below, shall be painted with one coat of sealer, two undercoats and one top coat of oil based heat resisting paint to BS 4800. All paint used shall be lead free. The colour for all painted surfaces shall be approved before painting is commenced. Where piping is finished in insulation, the pipework shall be finished in two coats of red oxide.

The following surfaces shall not be painted: stainless steel, chromed or vitreous enamel surfaces and goods fabricated from copper, brass or gunmetal.

Bright or machined faces which have become pitted or marked by rust shall be replaced. Damaged paintwork or equipment supplied shall be made good to the manufacturers finish.

Should any rust appear after the initial painting the item shall be wire brushed to remove rust and defective paint and repainted with zinc rich paint before final painting.

All engineering equipment shall be sealed against entry of damp atmosphere before despatch from the makers works, and all chrome plated parts protected from deterioration by covering with gummed paper or painted with lacquer before delivery and cleaned off prior to handover.

All painting shall be carried out by skilled tradesmen.

Galvanising shall be supplied by the hot dipped process except where otherwise approved all iron and steel shall be galvanised after sawing, shearing, drilling, punching, polishing and machining are complete and all roughness to be removed prior to painting. Where the galvanised surface is removed the area shall be painted with a zinc rich primer before any rusting commences.

The zinc coating shall be smooth, clean, of uniform thickness and free from defects. Galvanising shall not adversely affect the mechanical properties of the coated material.

Plant identification shall comply with BS 1710 latest edition. Pipework shall be identified by painting completely in specified colour and banding all in accordance with Part C.

The backs of frames brackets, and the like and other inaccessible surfaces are to be well painted with the specified primary paint before the items are fixed. The tint of each undercoat is to differ from that of the preceding coat, but it must tone with the colour of the relevant finishing coat.

While materials for the Works may be obtained from several makers, undercoats and finishing coats for a particular surface must be obtained from the same paint manufacturer. It shall be ensured that the primary coat is suitable for finishing coat and vice versa.

Material shall be delivered from the manufacturers in sealed containers direct to site and used strictly in accordance with their instructions. When requested to do so samples of materials and/or applications and treatments shall be submitted for approval.

If necessary the relative number of under and finishing coats may be altered, if this is required by the selected manufacturer, provided that the total number of applications remain the same as specified, and this shall be included in the costs.



The 'preparation' for painting comprises everything necessary for the proper preparation of the relative surfaces before the application of decorating materials and includes ensuring that no moisture or dampness is present at any stage, and rubbing down between the application of the various coats. The 'preparation' shall be as follows:-

Aluminium surfaces shall be washed with white spirit and either carefully roughened with abrasive paper or treated with etching solution in accordance with the manufacturer's instruction.

Iron and Steel - before fixing, all dirt, weld slugs, splatter, rust and scale shall be removed from steel and iron by wire brushing and holes, and the like filled with hard stoppings. Oil and grease shall be removed with clean white spirit or naphtha.

Zinc and galvanised surfaces shall be washed with white spirit and where necessary treated with etching solution in accordance with the manufacturer's instructions.

Primary coats shall be as follows:-

Aluminium surfaces shall be treated with one coat of zinc chromate primer.

Iron and Steel surfaces shall be treated with one coat of based primer to comply with BS 2523 Type B & C.

Zinc and galvanised Steel shall be treated with one coat of zinc chromate primer. If it has not been possible to pre-treat the surfaces they shall be given one coat of calcium plumbate primer immediately after cleaning.

Bitumen paint shall be black bitumen coating solution, to comply with BS 3416 Type 1 for general use.

Where items of equipment are delivered to site pre-finished i.e. stove enamelled or a similar finish, care shall be taken to ensure that all the same colours match and do not differ in shade.

B52 DESIGN RESPONSIBILITY OF PLANT AND EQUIPMENT

Where a technical submissions (confirming the technical suitability of the plant or equipment) has been requested prior to an order being placed, the Contractor shall complete a standard technical submission form including :

- manufacturer's data / certified drawing *
- design check calculations
- certified performance levels
- QA documents
- builder's work requirements
- assembly and installation details
- O&M instructions
- a list of recommended spares

* Drawing provided by a manufacturer or supplier to indicate details of the produce, components or plant items which the manufacturer or supplier **guarantees** the supplied equipment will complete with.



B53 IDENTIFICATION OF PLANT

All boilers, pumps, tanks, cylinders, stokers, fans, switch gear, switches, panels, AHU's, fire dampers and all other plant items and items of control equipment shall be supplied with white Traffolyte or equal labels engraved in black lettering.

The labels shall be mounted on equipment and in the most convenient positions, and where appropriate screwed to the surface on to which they are being fixed. Care shall be taken to ensure labels can be read without difficulty and the material is suitable for the temperature of the surface to which they are attached.

Details of the lettering of the labels and the method of mounting or supporting shall be forwarded for approval prior to manufacture.

Operating positions of dampers, levers and handles shall be suitably indicated.

The wording on the plant identification labels shall be the same as on the record drawings and shall be adequate to describe the equipment installed.

All identification of plant must be completed prior to handover.

B54 VALVE IDENTIFICATION

All valves in plant rooms, tank rooms and ceiling and floor voids, ducts and chases shall be fitted with labels engraved in black lettering to indicate the valve number and service it controls.

Each label shall be secured to the valve by means of a key ring.

Care shall be taken to ensure that the label material is suitable for the temperature of the surface to which it is to be attached.

Details of the lettering of the labels shall be forwarded for approval prior to manufacture. The numbering and lettering shall be shown on the record drawings, as detailed in the Clause headed "Record Drawings" above.

B55 IDENTIFICATION OF PIPELINES

Unless otherwise specified in Part C all insulated and uninsulated pipelines shall be identified in accordance with Part C.

B56 REMOVAL OF RUBBISH

All rubbish and materials not required shall be cleared from the site as they accumulate and the whole of the installation and working areas left in a clean and tidy condition.

All lamps and luminaires shall be disposed of by an approved Contractor.

B57 PRIVATE CARS

Private cars will under no circumstances be allowed within the site complex including that area designated for the temporary sheds, offices, mess rooms, and the like without permission.



B58 UNAUTHORISED VISITORS

Unauthorised visitors shall not be allowed access to the site nor the taking of photographs. A strict security of the site against such matters shall be maintained.

B59 RESPONSIBILITY FOR WORKS

Until each section of the Works has been formally taken over, the responsibility for such sections of the Works whether under construction or during test, or in service use will not change (save as provided in the Conditions of Contract).

B60 RECORD DRAWINGS

During the progress of the Works, the information necessary for preparing the installation record drawings shall be recorded on drawings in an approved manner. The marked-up drawings shall be made available for inspection and checking upon request.

All record drawings shall be computer generated at scale 1:1 and have notes prepared using the full width Roman Simplex font, not in its condensed form, at the correct height i.e., 400 for a drawing at 1:200 scale, 200 for 1:100 scale, 100 for 1:50 scale and 40 for 1:20 scale.

All drawings shall be suitably layered, and each layer shall be given short descriptive names e.g., POWER, NOTES etc., Numbers shall not be used for this operation.

All record drawings shall be single service drawings, i.e. separate drawings shall be provided for each service e.g., Domestic Water Services, Internal Drainage, Heating and Chilled Water Services, Ventilation, Power, Lighting, Fire Alarms, and the like, and shall indicate the following :-

- (1) The positions of all plant and apparatus.
- (2) The sizes, types and routes of all pipework, cables and conduits.
- (3) The exact routes and invert levels and the sizes, types and dates of installation of all underground pipework.
- (4) The exact routes and invert levels and the sizes, types, makes and dates of laying of all underground cables.
- (5) The exact positions and descriptions of all underground joint boxes and earth electrodes and the name of the jointers responsible.
- (6) The lengths of all underground cables between joint boxes and terminations.
- (7) The locations of any other services or obstructions in the routes of underground pipework and cables.
- (8) The positions and reference numbers of all valves. For plant rooms and boiler room layouts additional valve diagrams shall be provided where necessary for clarity. Reference numbers on drawings shall correspond with the numbers on valve labels.
- (9) The reference numbers of all electrical circuits. Each circuit reference number shall be carefully checked against the installation and updated distribution diagrams produced compatible with the record drawings.
- (10) The location and reference numbers of access panels in suspended ceilings.
- (11) Record drawings shall also include diagrams of connections of mains distribution, mains switch gear with protective equipment, plant, control systems, alarm systems and call systems. Diagrams of connections shall show identification of terminal and cable ends, size and type of cables, rating of switch fuses and circuit breakers, and overloads in motor starters.

Record drawings shall also be provided for all plant and equipment which, together with the printed instructions provided, shall be sufficient to enable the plant and equipment to be operated, maintained, dismantled, re-assembled and adjusted.



All record drawings shall be submitted for examination. On receipt of final comments, the following sets of record drawings shall be provided:-

- (1) One complete set of negative drawings on suitable plastic material.
- (2) Two complete sets of prints on paper.
- (3) One set of prints on suitable plastic material of those drawings showing plant, boiler and switchroom layouts, together with their associated valve diagrams and diagrams of main electrical connections. Each of these prints shall be mounted in a glazed frame on block mounted plastic laminate and hung in the room housing the relevant equipment.
- (4) Two complete sets of all record drawings on 3½" floppy disks, suitable for transferring into an 'IBM' or compatible CAD computer system in either, DWG, DXF or IGES file format. Any record information that could not be originally generated on computer, shall be 'scanned' into computer format in either 'Rastar' or 'Vector' line types suitable for transferring into an 'IBM' or compatible CAD computer system, with all notes being re-typed accordingly.

The relevant record drawings of plant, equipment and instructions shall be completed by the date of Practical Completion, or Taking Over, of a part of or whole of the works. If the record drawings are not available, the Services Engineer will not recommend the issue of a Certificate certifying completion. If however, for other reasons, a Certificate of Practical Completion or Taking Over Certificate is issued in the absence of the drawings, a deduction of not less than 2.5% will be made from the value of the work certified pending completion of these drawings. This situation will also apply if the marked up drawings required to be produced during the progress of the works are not made available.

B61 INSTRUCTION AND TRAINING

Complete instruction, demonstration and training in the operation of all systems, plant, equipment and controls shall be given to the person(s) who will be responsible for running them.

The name(s) of the person(s) concerned will be supplied on application to the Services Engineer.

B62 SUPPLY OF COMPUTER HARDWARE AND SOFTWARE

If the works include for the provision of computer hardware and software associated with for example, a fire alarm, building energy management, or lift control system, the following conditions shall apply.

A Statement of Requirements for each system is given in other parts of this Specification. This section of the works shall warrant that each system fulfils all of the requirements and functions stated in the Statement of Requirements.

Prior to the equipment being delivered to site, pre-commissioning tests, the results of which shall be witnessed by the Services Engineer, shall be completed at the manufacturers premises.

The Statement of Requirements includes a "Trial Period" which shall precede any formal acceptance of the system and commence when the Services Engineer is notified in writing by this section of the works that the complete system is available for its intended purpose.

During installation, the hardware shall be delivered to site in accordance with the programme, or if no time or date is stated, within a reasonable time to enable the tests or verification routines to be completed prior to installation of the software.

Following successful passing of the tests and routines for the hardware, the software shall be provided, delivered, installed and fully commissioned as a part of this section of the works.



B63 SPARES

Spare parts and materials shall be provided as detailed elsewhere in this Specification.

Should it be considered that additional spares are desirable for maintenance of the installation, a list of recommended parts and materials shall be provided for approval.

B64 MAINTENANCE MANUAL

Four weeks prior to Practical Completion, or Partial Possession of the Works, two copies of a Draft Maintenance Manual shall be submitted to the Services Engineer for examination and comment. (Manufacturers literature and Record Drawings shall not be required at this stage).

Following receipt of final comments from the Services Engineer, and upon Practical Completion, of the Works, one copy of the approved Maintenance Manual shall be provided and handed to the Services Engineer, and two copies of the same documentation shall be handed to the Planning Supervisor for inclusion in the Project Health & Safety File.

If there is no Planning Supervisor appointed, then three copies of the approved Maintenance documentation shall be provided and handed to the Services Engineer, two copies being for the client and one copy for the Services Engineers records.

Each manual shall be of the loose leaf A4 size type, having a rigid cloth bound cardboard cover, subdivisions for each section, a ready means of reference and a detailed index. The text for the front cover shall be submitted to the Services Engineer for comments in a timeous manner to allow submission of the final copies of the manuals.

Each manual shall contain full operating and maintenance instructions for each system and item of equipment included in the Works.

The paper used in the final documents shall be of good quality high white 120 g/m² and the reproduction method shall be dry photocopy.

The arrangement of the Maintenance Manual shall be as follows:-

Section 1 - General Index

This section shall contain the Index, for the entire content of the manual.

Section 2 - Systems Operation

This section shall contain a description of each system, its operational intent, and a schedule of the parameters used as a basis for the design of that particular system.

Section 3 - System Operation & Set Points

This section shall contain a description of operational routines, which includes procedures to be followed to 'start up and 'shut down' items of plant, and how to undertake various testing procedures (e.g. Earth Continuity Test) and fault finding. A schedule of set point control settings for normal operation of each system shall also be included.

Section 4 - Planned Maintenance Instructions



This section shall contain a description of Planned Maintenance Instructions, for all systems and each item of plant and equipment, and must include step-by-step instructions, to supplement the manufacturers literature.

This section shall contain manufacturers literature. Relevant equipment data only shall be extracted from the manufacturers literature and included within these documents. Literature which contains descriptions of equipment which is of no concern to the end user, shall not be included.

Where equipment is non-standard, information for the Maintenance Manual shall be obtained from the manufacturer.

A full legend for the colour coding and all services.

Section 5 - Schedule of Plant & Equipment

This section shall contain a full schedule of all plant and equipment, including duty, electrical load, flow rates, and the like where applicable.

Section 6 - Commissioning Results

This section shall contain a full set of the commissioning results for each system, presented in a format which is easily understandable and which contains equipment and valve references which relate exactly to references noted on the installation and record drawings.

Originals of the following documentation shall be provided:-

- Main Plant and Testing Commissioning Sheets
- Chemical Cleaning Certificates
- Chlorination Certificates
- I.E.E. Inspection and Completion Certificates
- Fire Alarm System Test Certificates
- Manufacturers Test Certificates for Specialist Equipment (i.e. Chillers)
- Main Earth Mat Certificate
- Lightning Protection Certificate

Section 7 - Spares

This section shall contain comprehensive list of spare parts and materials as proposed and agreed with the Services Engineer.

Section 8 - Emergency Procedures

This section shall describe actions to be undertaken in the event of an emergency, and shall include a full directory of names, addresses and telephone numbers of individuals, or organisations (as agreed with the Services Engineer) to be contacted.

This section shall also include a description of the basic principles of First Aid.

Section 9 - Index of Record Drawings

This section shall contain an Index of all Record Drawings produced, indicating their numbers and titles.



Section 10 - Computer Disc

This section shall contain a CD containing a complete copy of the operating and maintenance documentation, excluding manufacturers literature, in Microsoft Word format, for transferring into an 'IBM' or compatible computer word processing package.

The three copies of the Maintenance Manuals shall be completed and issued to the Services Engineer by the date of Practical Completion, Partial Possession, or Taking Over.

Receipt of the completed Maintenance Manuals by the Services Engineer shall be a condition precedent to the issue of any Certificate of Practical Completion, or Taking Over Certificate.

If however, for other reasons a Certificate of Practical Completion or Taking Over Certificate is issued without the Maintenance Manuals being provided, a deduction of not less than 2.5% will be made from the value of the work certified, pending completion of these manuals.

All Maintenance Manuals shall be in compliance with BSRIA Document TN15/95.

B65 BUILDING LOG BOOK

The owner and/or occupier of the building should be provided with details of the installed building services plant and controls, their method of operation and maintenance and other details that collectively enable energy consumption to be monitored and controlled.

The information should be provided in summary form, suitable for day-to-day use. This summary could draw on, or refer to, information available as part of other documentation such as the Operation and Maintenance Manuals and Health and Safety File.

The details to be provided shall include :

- a) A schedule of the floor areas of each of the building zones categorised by environmental servicing type (e.g., air conditioned, naturally ventilated).
- b) A description of the whole building, its intended use and design philosophy and the intended purpose of the individual building services systems.
- c) The location of the relevant plant and equipment, including simplified schematic diagrams.
- d) The installed capacities (input power and output rating) of the services plant.
- e) Simple descriptions of the operational and control strategies of the energy consuming services in the building.
- f) A copy of the report confirming that the buildings services equipment has been satisfactorily commissioned.
- g) Operating and maintenance instructions that include provisions enabling the specified performance to be sustained during occupation.
- h) A schedule of the building's energy supply meters and sub-meters, indicating for each meter the fuel type, its location, identification and description and instructions on their use. The instructions should indicate how the energy performance of the building (or each separate tenancy in the building where appropriate) can be calculated from the individual metered



energy readings to facilitate comparison with published benchmarks (see paragraphs 6-9 in Appendix G). Guidance on appropriate metering strategies is given in paragraph 3.3.

- i) For systems serving an office floor area greater than 200m², a design assessment of the building services systems' carbon emissions and the comparable performance benchmark. (See paragraph 4 in Appendix G).
- j) The measured air permeability of the building (see paragraph 2.4).

NB The above references relate to Part L2 of the Building Regulations.

B66 KEYS, TOOLS AND ACCESSORIES

All keys, tools and accessories required for the proper running and maintenance of the plant, together with one spare tin of oil or grease of each type necessary for the correct maintenance of the system(s) installed shall be supplied, as part of this section of the works, prior to handover.

B67 AIR TIGHTNESS OF BUILDING STRUCTURES

Where the Services Contractor is responsible for or involved with the pressure testing of building structures it is deemed that this shall be carried out in accordance with CIBSE TM23 and BSRIA TN19/2001.

Tests to include initial test and sufficient number of retests (after remedial action) to satisfy Part L2 of the Building Regulations.

Full certification of test(s) and any remedial measures must be provided.

B68 HANDOVER

When the installations are practically complete, with all accessories, components, spares and tools provided; that all testing, commissioning, and instruction has been satisfactorily completed and that all 'Record' drawings together with all valve diagrams, wiring diagrams, maintenance manuals and instruction charts have been provided, a recommendation will be made to hand over the installations.

A Certificate of Practical Completion or Taking Over Certificate will be issued following the official handover of the Works.

B69 DEFECTS LIABILITY PERIOD

Unless otherwise stated the Defects Liability Period shall be for 12 months from the date of Practical Completion or Taking Over of the Works included in this Specification.

If it becomes necessary to replace or renew a defective portion of the Works under this clause the provision thereof shall apply to the portion so renewed or replaced until the expiration of 12 months from the date of such replacement or renewal.

If the Defects Liability Period for the building work is 6 months from the date of Practical Completion or Taking Over then at the end of the six months Defects Liability Period monies will be retained for a further six months for completion of the outstanding work under the Defects Liability Period for work included in this Specification until such time as a Certificate of Completion of Making Good Defects is issued.





PART C - SECTION 1 PARTICULAR DETAILS

CONTENTS

C1.1	GENERAL
C1.2	GENERAL DESCRIPTION OF WORKS.....
C1.3	DETAILS OF EXISTING SERVICES & EQUIPMENT
C1.4	BUILDERS WORKS IN CONNECTION.....



PART C - SECTION 1

PARTICULAR DETAILS

C1.1 GENERAL

This part of the Specification details the General Technical Requirements for plant and equipment to be installed under this Section of the Works.

All necessary, additional and secondary steelwork and other equipment required to provide an adequate and complete support of the services shall be provided for the services which form a part of this section of the works.

Specific plant and equipment details are provided in the Schedules of Technical Requirements included within Part D of this Specification, or indicated on the drawings.

This Section of the Works includes the responsibility for ensuring the manufacturer of a particular product is furnished with both the general, and specific, technical requirements information for that piece of plant and equipment.

Please note for the avoidance of doubt, the particular sections of this specification are parts C1 and D. If there is any contradiction or conflict between these sections and any other general ones then this hierarchy should apply. However, any such instance should be pointed out to the Engineer in writing and clarification sought.

C1.2 GENERAL SCOPE OF WORKS

The mechanical building services works shall include for the procurement and installation of all mechanical building services, the whole being based upon the parameters set out within this document. The mechanical services element of the works, shall briefly comprise the following:

- a) Non utility MCWS
- b) Non utility natural gas distribution
- c) All gas fired central heating plant
- d) All pressurisation, expansion and circulation equipment for heating
- e) All domestic hot water generation plant
- f) Domestic hot and cold water installations
- g) LPHW space heating installations
- h) Mechanical ventilation systems
- i) Heating and Comfort Cooling systems
- j) Above ground foul drainage systems
- k) Automatic controls systems for the above mechanical plant



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- l) Provision of all thermal insulation to pipework and ductwork
- m) Testing, commissioning and demonstration of all mechanical services
- n) Operating and maintenance manuals and record drawings

C1.2.3. Non-Utility MCWS.

A new potable water main shall be laid to an appropriate incoming position within the building as indicated on the tender drawings, from here a water supply shall serve the first floor potable water quality storage tank and booster set.

The cold water from the storage tank shall be distributed to the various water appliances throughout the building.

A main isolation valve and water meter shall be provided on the supply as it enters the building.

A supply shall be taken from the incoming main, to serve the external bib tap.

The mechanical services contractor shall provide an adequately sized water supply system from the new storage tank and booster set to all cold water draw off points within the building together with cold water feed points for all HWS cylinders, showers and electric and gas fired water heaters as shown on the tender drawings.

The mechanical services contractor shall arrange for testing of the incoming water quality and liaise with equipment manufacturers to determine any requirements for water softening equipment. Pipework shall be suitably arranged as to allow effective venting of air from the system.

All pipework to be co-ordinated with architectural design, dropping pipework to be concealed where possible.

The mechanical services contractor shall contact the water utility company to programme the works, to provide updated quotations as required.

The mechanical services contractor shall provide all necessary information required by the utility providers and shippers.

All direct costs incurred by the statutory authorities shall be paid by the client.

Any underground pipework required shall be corrosion resistant with oxygen barrier due to existing ground contamination.

C1.2.4. DIVERSION OF NON UTILITY GAS DISTRIBUTION PIPE.

The contractor shall investigate the suitability of the existing gas main serving the site. If necessary, the contractor shall liaise with the public utility services providers to upgrade and reconfigure the gas main to suit the requirements of the development.



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The mechanical services contractor shall contact the gas and water utility companies to programme the works and to provide updated quotations as required. The mechanical services contractor shall provide all necessary information required by the utility providers and shippers.

All direct costs incurred by the statutory authorities shall be paid by the client.

The contractor shall install all new gas distribution from the incoming meter position to serve all items of gas fired plant.

All gas pipework running through ceiling voids and boxed in etc. shall be ventilated in accordance with The Institute of Gas Engineers guidance, relevant BS Codes of Practice and The Gas Safety Register notes.

The gas supply to the building shall incorporate an automatic gas shut-off valve assembly, with heat detectors provided over each boiler, and an emergency shut-off button, all complete with an interlink to the fire alarm system.

The gas shut-off systems, purge and restart following the operation of the gas supply interlocks, shall be fully compliant with the current Regulations.

Appropriate gas line diagrams shall be provided within framed charts within the service intake areas of the building. Gas pipework shall be clearly colour coded. A gas isolation valve shall be installed at the entry to the building and on the meter outlet.

The Contractor shall include for the final termination connection to all items of gas equipment and shall include isolating valves at all branches and purge points.

Throughout, the gas pipework shall be distributed through ventilated enclosures in accordance with the requirements of the Gas Safety Regulations 1998. Where necessary, suitable 'pipe-in-pipes' shall be utilised to provide this ventilation.

Gas pipework to be sized on a maximum of 1 mbar pressure drop from the meter to the furthest appliance.

C1.2.5. BOILER PLANT.

The contractor shall supply, install, deliver and commission 2No. new Hamworthy Fleet F150W gas fired wall mounted condensing boilers as shown on tender drawings.

The heating system and heat emitters shall be selected to operate on 80°C flow and 60°C return. The boiler shall be provided with a weather compensation system to maximise the efficiency of the installation. The contractor shall ensure that the boilers are commissioned and set to operate at these temperatures.

The Heating system shall be fully flushed out in accordance with CIBSE commissioning TM and refilled with chemical treatment as described in Part C2 of this specification.

The mechanical services contractor shall allow for all drainage as required to drain condensate from the boilers to a suitable drainage point.



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The mechanical services contractor shall allow to select, supply and install an appropriate automatic pressure by pass valve to the heating circuits, so as to allow flow when all TRV's or two port zone valves have closed.

C1.2.6. PRESSURISATION AND EXPANSION UNIT.

The whole of the LTHW distribution system shall be pressurised by means of a dual pump pressurisation unit complete with a suitably sized pressure vessel and break tank.

A dosing pot and dirt & air separator shall be provided on the system.

All necessary commissioning stations and isolation facilities shall be incorporated to ensure the system can be effectively balanced and sections isolated for maintenance. Pipework expansion shall be considered and all necessary provision made in the form of bellows, anchors, guides, loops etc.

C1.2.7. CIRCULATION PUMPS.

LTHW circulation shall be by means of a pumped primary circulation within the plantroom, this circuit incorporating dual pumps operating on a run and standby basis with auto-change and duty sharing control.

The heating distribution systems will be split into suitable distribution zones.

All LTHW heating circuit pumps shall be in-line twin head variable speed canned rotary type. All pumps shall be fitted with differential pressure switches and inverter driven.

Each individual pumped circuit shall be protected by an in-line strainer with local isolating valves positioned immediately upstream and downstream. Flexible connections shall be provided on each pump set, or spring hangers on pipework brackets up to 100 pipe diameters from the pump on suction and delivery sides.

The contractor shall also supply a spare Pump1 and mount on bracket within the Boiler Plant room.

C1.2.8. DOMESTIC HOT WATER GENERATION PLANT.

The contractor shall supply, install, deliver and commission a Hamworthy Dorchester DR-FC Evo 80 hot water generator as shown on tender drawings and as described in Section D3 technical requirements.

C1.2.9. DOMESTIC HOT WATER (DHW) AND MAINS COLD WATER SERVICES.

The contractor shall provide a new suitably sized compartmented potable quality insulated cold water storage cistern to be mounted within the new plantroom. The cold water storage cistern shall be WRAC approved and sized to provide a minimum of 12 hours storage to maintain the supply in the building in the event of an interruption to the main supply.



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The contractor shall also provide a new packaged pressure booster set and water conditioning equipment within the new plant room, to condition and boost the cold water to all hot and cold water outlets throughout the new building.

The cold water pressure booster set shall be a variable speed two pump type packed booster set. The two pumps shall operate in a run / standby configuration. This packaged booster set shall incorporate a pressure vessel, duty pump changeover function, control panel, variable speed pumps, volt free contacts for faults, pressure set point adjustment, anti vibration mountings and expansion joints.

Pressure reducing valves shall be installed to ensure consistent cold water pressure throughout the building.

The mechanical services contractor shall install new hot water generation system as the tender drawings. The hot water generation shall comprise a new direct gas fired condensing water heater located within the plant. Domestic hot water shall be stored at 60°C.

A suitably sized hot water secondary return circuit and bronze pump shall be provided to maintain the temperatures within the domestic hot water pipework. A spare secondary return pump shall be wall mounted in the plant space. The DHW circuit shall incorporate thermostatic regulating valves with presetting to automatically support thermal disinfection.

The cold water supplies to water heaters shall be taken from the booster set and shall incorporate all necessary expansion / pressure reducing sets.

The mechanical services contractor shall also allow for all hot and cold water distribution pipework to serve all outlets within the building as shown on the tender drawings. The installations shall be fully compliant with the current British Standards, Water Regulations and requirements of the local water company.

Where hot and cold water pipework run parallel to each other, the cold water pipework will be installed below the hot water pipework to minimise heat transfer from the hot water.

The mechanical services contractor shall include for all thermostatic blending valves as required and indicated on the tender drawings. All applicable hot water outlets shall be blended locally to 43°C max. at outlets. The maximum length of mixed water pipework from any single thermostatic mixing valve to be 2m. Where hot water outlets are not automatically blended to 43°C, permanent notices shall be fixed adjacent to the outlet providing the user with a clear warning of very hot water discharge.

The mechanical services contractor shall include for thermostatic mixing showers where required and as indicated on the tender drawings.

The mechanical services contractor shall include, as necessary, for the provision in the appropriate branch pipework for pressure reducing valves, to limit the pressure at draw off points.

All water appliances shall have water flow regulating valves fitted. All water equipment shall have pipeline size ball type isolating valves fitted.



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Urinals shall be served via a 'cisterniser' type (or equal and approved) flush control device and high level cistern.

All hot and cold water pipework shall be in insulated copper (chrome/bright stainless steel where exposed in fully tiled areas). Insulation on cold water pipework shall also be vapour sealed.

Pipework shall be suitably arranged as to allow effective venting of air from the system.

All pipework to be co-ordinated with architectural design, dropping pipework to be concealed where possible.

The mechanical specialist shall arrange for the water company to inspect the proposal drawings (for Regulation approval) and inspect the installation on site (for Regulation sign-off)

Chlorination to British Standards and Water Regulations requirements shall be undertaken. The systems shall be fully compliant with current Legionella Code Of Practice.

Back-flow prevention devices shall be fitted where necessary.

Brassware and sanitary ware are excluded from this specification.

The mechanical services contractor shall allow for reviewing the final sanitaryware schedule to ensure compatibility with the domestic water services installation. Any discrepancies shall be identified and brought to the attention of the Engineers.

C1.2.10. LPHW SPACE HEATING INSTALLATION.

The contractor shall supply, deliver, install and commission Sensotherm LST radiators as shown on tender drawings. All radiators shall be installed with Drayton TRV4 (Thermostatic radiator valves) and Crane CP lock-shield valves.

All radiators to be fitted with thermostatic valve on the flow connection and lockshield valve on the return. TRVs shall be complete with lockable covers.

Areas where it is impractical to serve via the LTHW system shall be served by wall mounted electric panel heaters as indicated on the tender drawings. The heaters shall be complete with integral thermostats. All electric heating shall be switched via a central time clock.

The installations shall be pressure tested prior to insulation to 1.5 times working pressure or 5 bar whichever is greater and a certificate signed by a site official.

Following completion of the heating installation the contractor shall flush the system and provide inhibitor as recommended by the boiler manufacturer.

Pipework shall be suitably arranged as to allow effective venting of air from the system.

All pipework not serving as a useful heating surface shall be insulated in accordance with TIMSA requirements.



Where radiators are to be provided these should be supplied pre-finished to a colour agreed with the architect.

All heating pipework shall be distributed throughout the building ceiling voids, dropping to serve heat emitters where appropriate and as indicated on the tender drawings. All pipework to be co-ordinated with architectural design, dropping pipework to be concealed where possible.

All LPHW distribution pipework to be in steel.

C1.2.11. MECHANICAL VENTILATION SYSTEMS

The contractor shall allow for the supply and installation of all mechanical ventilation installations, in accordance with this specification and the relevant tender drawings.

Mechanical ventilation to the ground floor general areas and surgical areas to be provided by supply and extract heat recovery air handling units located within the first floor external plant area. The unit shall meet the performance and configuration as indicated in the schedule and detail drawings. The air handling unit shall be tested to BS848 Part 1 and shall be of the MAX A & MAX C type as manufactured by VES Andover Ltd a company accredited with BS EN ISO 9001:2008.

The unit shall conform to the schedule regarding case construction, component layout & finish. The detail drawings shall be supplied for approval where indicated in the schedule.

The unit shall be complete with all necessary dampers, filters, coils, access panels and bulkhead lighting so as to ensure compliance with relevant Health Technical Memorandae.

Ventilation to the Gym, gym showers and gym WCs to be via a Mitsubishi Lossnay ducted heat recovery unit.

Where necessary, and indicated on the tender drawings, make up air shall be supplied to adjacent spaces and door transfer grilles provided.

The minor surgery shall maintain a positive pressure when in use. Air supplied to this space shall pass through a door transfer grille complete with adjustable pressure relief damper.

WCs shall generally be provided with ducted extract only ventilation systems as indicated on the tender drawings. Public WCs within the existing building will be provided with extract ventilation via an inline fan located within the loft space. The fan shall discharge through a weatherproof roof cowl.

Ductwork shall be galvanised mild steel, designed, constructed and installed in accordance with HVCA ductwork specification DW/144 Low Pressure Classification. Provisions for ductwork cleaning shall be in accordance with CIBSE Publication TR17, level 2 as a minimum.

Contractor to make allowances for all required fire dampers as indicated on the tender drawings and in accordance with the architectural fire strategy drawings.

All ductwork shall be clean when erected and shall be continuously protected during installation against the ingress of dirt, debris and vermin.



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All ductwork and air handling plant shall be leakage tested to a standard appropriate to its operating pressures.

The Contractor shall make all allowances for the following as indicated on the tender drawings:-

- a) Duct access doors for maintenance cleaning and inspection.
- b) Volume control dampers to be installed at branch off-takes.
- c) Fire and smoke dampers with actuators together with remote indication.
- d) Ductwork attenuators within main branches.
- e) Crosstalk attenuators where crosstalk cannot be avoided by design.

In the event of the test showing leakage, the Mechanical Services Contractor shall be responsible for sealing and re-testing until a satisfactory result is obtained.

The air handling units serving these areas incorporate heat recovery via plate heat exchangers, face bypass dampers and include duty and standby fans on the extract section. Heat exchangers shall be complete with automatic summer bypass facility.

These systems are to be commissioned to provide the fresh air volume to meet the occupant's needs and the level of extract necessary to maintain the freshness within the hygiene zone. Under normal operation the balanced air volumes are designed to provide a minimum of 2.5 air changes per hour (or 10l/s/p whichever is the greater) in occupied areas and a minimum 10 air changes per hour in the toilet/hygiene accommodation whichever is the greater figure will be the design volume.

All ventilation systems to include plate heat exchangers complete with automatic summer bypass facility as necessary.

Intake and discharge terminals on air handling plant will be suitably positioned to ensure cross contamination does not occur.

Fan motors shall be inverter driven to minimise the electrical load on start up.

ANTI VIBRATION MEASURES

The Mechanical Services Contractor shall include all measures available to isolate the transmission of noise and vibration from mechanical plant to the structure.

For axial flow fans supports shall be either isolated hanger or captive spring type mounts, depending on the application.

The Mechanical Services Contractor shall be responsible for the selection and performance of all anti-vibration isolation material for all items of mechanical plant to satisfy the design requirements.



LOUVRES

The Mechanical Services Contractor shall include for the supply and installation of all ventilation discharge air louvres required throughout for ventilation systems and plantroom ventilation requirements.

All louvres shall be treated to withstand corrosion and shall be manufactured specifically for external use, designed to prevent ingress of driving rain. They shall incorporate drip-bars and bird screens to the whole of the rear face.

The Mechanical Services Contractor shall include for louvres to be supplied to any RAL colour to match the local décor. The Contractor shall include for all builders work details to be provided to the Main Contractor.

Where appropriate, acoustic louvres shall be utilised (in conjunction with silencers) to achieve the necessary attenuation requirements.

C1.2.12.HEATING AND COMFORT COOLING SYSTEM

The contractor shall supply, deliver, install and commission a new Daikin three pipe VRF system as shown on the tender drawings. The new cassettes will be wall mounted. Refrigeration pipework from the cassettes shall be routed through the ceiling void. Refrigeration pipework shall be installed on galvanised cable tray systems within the ceiling void and routed to external condensers.

The design of the heating and comfort cooling systems will be based on temperatures of:

External Winter	-4°C.
Internal Winter	21°C
External Summer	30°C
Internal Summer	21°C

All cassette units shall include a condense pump to lift condensate into a gravity drainage system which shall incorporate rodding eyes at all changes of direction and end of runs.

The Heating/Comfort cooling systems shall incorporate all field wiring (control and power) as part of the 'package', the system shall include individual local controllers. Also included as part of the 'package' shall be the installation of the system, with all commissioning of the system being undertaken in accordance with the manufacturer's recommendations/requirements.

Refrigerant pipework shall be of solid drawn seamless copper tube to BS EN 1976 and BS EN 1978, with tolerance to BS EN 12449 specially cleaned for refrigerant purposes then sealed. Following installation, pipework shall be pressure tested and subject to a vacuum as required by the equipment manufacturer's recommendations.



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All joints shall be made in accordance with the manufacturer's using only their recommended fluxes, solders, jointing compounds and the like and left clean after completion.

The use of bending machines on pipework over 42mm shall not be permitted.

Refrigerant mains external to the building structure shall be painted to protect insulation against degradation by UV rays.

Where exposed, the pipework shall be supported with polished cast gunmetal clips.

Pipework installed in service ducts, ceiling voids, external or together with other service pipework shall be supported by cable tray from common angle or channel iron supports.

All pipes shall be supported at not more than the following intervals:-

<u>Size of Pipe (mm)</u>	<u>Interval for Supports (mm)</u>
15	1200
22	1200
28	1500
35	1500
42	2000
54	2000
67	2000
76	2000
108	2400
135	2700
159	2700

In locations prone to potential mechanical damage refrigerant pipework shall be suitably protected with inverted tray (plane) having appropriate spacers to clear the insulation material.

Refrigerant pipework shall be insulated as indicated in Section C13 of this specification.

Where pipes pass through walls, floors and the like sleeve pipes and floor plates shall be provided.

In all cases refrigerant works shall be carried out in accordance with BS 4434 (Safety and Environmental Aspects in the Design Construction and Installation of Refrigerating Appliances and Systems), the Institute of Refrigeration Safety Codes and HSE Guidance Note PM81.

All field wiring from condensers to cassettes and controllers shall be carried out by specialist mechanical contractor.

All works shall be carried out in accordance with Part C12 of the specification.

C1.2.13.ABOVE GROUND DRAINAGE

The contractor shall supply, deliver, install and commission above ground drainage to serve Boiler plant room, proposed toilets, beverages room, kitchen, cleaner's cupboard and new consulting rooms



as shown on architects drawings complete with deep seal bottle traps and in accordance with Part C17 of the specification.

C1.2.14.AUTOMATIC CONTROLS SYSTEMS

GENERAL

A Building Energy Management System (BEMS) shall be provided to control and monitor the mechanical services installations.

The BEMS system shall provide the following functions as a minimum:

- Heating optimum start/stop.
- Plant room panic buttons – one per exit to shut all plant down.
- Fire alarm interface with gas solenoid valve shut.
- Pump lead/lag operation and duty sharing.
- Boiler sequence control.
- Night set back/frost control.
- Energy monitoring of all meters.
- Control of pressurisation unit
- Gas safety within the plantroom
- Plant failure indications

The total automatic controls installation, including interconnecting power and control wiring, shall form part of the works in this specification and a specialist ‘controls company’ shall be solely responsible for the design, supply, installation and commissioning of the entire automatic controls installation.

The controls specialist shall supply all equipment and interconnecting wiring necessary for the satisfactory operation of the equipment and system installations in accordance with manufacturer’s recommendations, whether specified in detail or not, and shall upon completion of the installation satisfactorily test and commission all the controls systems. The control system front end shall be located in the Admin Office.

All necessary cable tray, piping, wiring, fittings and fixings required for the complete automatic controls installations shall be supplied, installed, tested and commissioned.

Any automatic control equipment fitted into the works, which is not installed by the controls engineer, shall have its installation supervised by the controls engineer.



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Temperature detectors installed in a tank, calorifier or pipeline shall be protected with a separate pocket of suitable material. Detector pockets and items of controls equipment shall be installed in the pipework and ductwork systems in the positions determined by, and under the supervision of, the controls engineer.

Unless otherwise indicated in this specification, all electrical actuators and linkages and mechanisms shall be provided by the controls engineer to suit motorised dampers, valves and the like as necessary. This shall include the provision of motor(s) of adequate power and suitable linkage mechanism(s) on each motorised damper to enable operating motor(s) to properly drive the damper blades to their correct position. The controls engineer shall supervise the installation of all such linkage mechanisms.

Unless otherwise specified all necessary information regarding loads and duties of equipment shall be obtained by the controls engineer from the mechanical Contractor and the tender prepared accordingly. This shall include, but not be limited to, the following where applicable: -

- Motor sizes (rating, full load current and number of phases)
- Electrical supply details
- Heater battery flow rates and pressure drops
- Low-pressure hot water valve requirements (i.e. flow rates and circuit pressure drops)
- Damper motor requirements
- When ordering the control panels, final confirmation of the above information shall be given to the controls engineer. All starters for motors rated at over 3.9kW shall be star-delta and all two speed motors shall be of the dual wound type.
- Unless otherwise specified all 3-port valves shall close to load when switched off.
- Unless stated otherwise, starters for all mechanical services equipment shall be provided by the controls engineer and housed in the control panels.
- Where airflow failure sensors are specified, these shall be of the pressure differential type. Anti-flutter timers shall be provided in the panel for these sensors.

Where differential pressure sensors are specified, the controls engineer shall provide suitable plastic tube, clipped and secured as necessary, from the controller to the positions where the pressure is being monitored.

CONTROLS ENGINEERS RESPONSIBILITY

The details in this section of the specification and associated drawings indicate the design intent for the operation of the controls. It is the controls engineer's responsibility to verify and ensure the controls specified, both in quantity, size and type, and their mode of operation, fully comply with the design intent shown, and provide a complete installation.



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The controls engineer shall select the correct type of, and confirm the position of all sensors, thermostats, controllers and the like to the mechanical Contractor and ensure that they are in a location that will enable correct operation of the systems.

The controls engineer shall carry out all site revisions necessary to the controls installation in order to provide the specified description of operations.

Wiring diagrams, general arrangement drawings for the control panels and the required location of all items of equipment associated with the controls installation shall be indicated on drawings prepared by the controls engineer and submitted to the services engineer for comment via this section of the works, all being in accordance with the provision of the installation drawings detailed elsewhere within this specification.

All controls wiring diagrams submitted for comment shall be accompanied by a complete description of the operation of the automatic controls systems. Details of any special wiring requirements (i.e. screened cables) necessary to ensure the correct operation of each controls system, shall be submitted with the tender offer and be included on the above diagrams.

The controls engineer shall demonstrate in full to the services engineer the satisfactory operation of the entire controls installation and associated mechanical services systems that it serves. Allowance shall also be made for separate similar demonstrations to the Client's representative.

MULTI MOTOR PANELS, CUBICLE TYPE SWITCHBOARDS AND CONTROL CUBICLES

Control panels shall comply with the EMC Directive and BRE Digest 424 (BRE 1997) in respect to electromagnetic interference.

Multi motor panels shall consist of a number of starters mounted together under a common isolator.

Busbars and busbar connections shall be constructed in accordance with BS EN 60439-1 and BS 159. Busbars shall be made of hard drawn high conductivity copper; rated as specified. The busbars and connections shall be capable of withstanding the specified short circuit conditions.

Panels are to be constructed as follows.

Compartments for motor controls incorporating: -

- Door interlocking fused isolator; this isolator must also isolate the starter coil circuit and any control circuits entering the compartment at and over 240V.
- Motor starter.
- Door-mounted switches and lamps.
- Door-mounted indicating equipment.

Any automatic controls or monitoring equipment, i.e. compensator, timeswitches, dirty filter lights which are associated with a specific plant shall be incorporated into the motor compartment serving that plant.



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This separate compartment shall have a door interlocking isolator, which shall isolate all the incoming circuits in order that maintenance can be safely carried out.

The door interlocking isolator specified above shall be so arranged that it shall not be possible to close the switch with the door open, except that provision shall be made within the compartment for an authorised person to defeat the mechanical interlock and close the switch with the door in the open position for test purposes.

Cut-outs shall be accurately cut and all edges finished smooth and free from burrs and burns.

All doors shall be hinged and complete with gaskets

A removable drilling plate shall be provided adjacent to the point of cable entry for cable glands and conduit terminations.

Where practical components shall not be mounted on panels capable of movement, e.g. doors.

For all floor-mounting panels removable lifting lugs shall be provided.

All handles and locks shall be chromium plated.

LABELS AND COMPONENT IDENTIFICATION

The type, material and method of fixing labels shall be to approval.

Each panel shall carry a warning label stating 'Danger' and the voltage present in 13mm high red letters on a white background.

Each control and indicating device on the front of the panel shall have its function marked adjacent to it.

Each multi-position switch on the front of the panel shall have the function of each marked adjacent to it.

Components shall be labelled with schematic circuit diagram identification reference.

Cable number as the schematic circuit diagram shall be indicated by suitable markers on cable ends. The ends of each connection shall be fitted with crimp terminal tags.

Components (General)

Components used in control panels shall comply with the following British Standards: -

Busbars and busbar connections. BS 159 and BS EN 60439-1

Motor starters and controllers. BS EN 60947-4-1 and BS 5856: Part 1 and BS EN 60439-1

Contactors. BS 775 and BS 5424

Air break switches and isolators. BS EN 60947-3

Heavy-duty composite units of air break switches and fuses. BS EN 60947-3



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Colours of indicator lights and push buttons.

BS EN 60073

The performance of a.c. motor control gear equipment up to 1000V a.c. for use on high prospective fault current systems.

BS 5486, BS EN 60439-1 and BS EN 60947

HRC fuses - ASTA indicating pattern to

BS 88, category of duty 440 a.c.5.

Measuring Instruments

All instruments shall be flush panel-mounted and all bezels and escutcheon plates shall be colour 557.

The scale length of all indicators and recorders shall be slightly less than the full travel of the instrument so that there is a clear indication when the pointer is off scale.

The instrument ranges shall be so arranged that the normal working indication is at a point approximately two thirds of the full-scale deflection.

All instrument scales shall have black divisions on a white background.

Indicator Lamps

The colour of indicator lamps shall be: -

Machine running	GREEN
Machine stopped	RED
Machine failed	RED
Supply on	GREEN

Indicator lamps may be of the neon or filament type.

Where practical the voltage supplied to filament type pilot lamps used on a.c. shall be supplied with a voltage approximately 20% less than the nominal value in order to extend their life.

Push Buttons

The colour of push buttons shall be: -

Start:	GREEN	Full guard
Stop (normal):	RED	Half guard
Emergency stop:	RED	Mushroom head
Bypass (lockout)	RED	Mushroom head
With main contact assembly: -		
Re-set	GREY	Full guard
Inch forward	BLACK	Full guard



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Reverse misc.

BLUE

Full guard

The above colour code applies also to illuminated push buttons. All push buttons shall be oil tight pattern and legend plates shall be provided.

Timeswitches

Each timeswitch shall incorporate a spring reverse to enable it to function for a period of at least thirty hours after interruption of the supply.

Contactors

Each contactor shall be suitable for the electrical and mechanical duty it has to perform.

Starters

Each starter shall be suitable for the electrical and mechanical duty it has to perform and as detailed later in this section of the specification.

Component Mountings

Components shall be so mounted that they can be inspected, removed and replaced without damage or undue disturbance to other components or wiring.

Where a component has a single point mounting positive means of preventing rotation of the component body relative to the mount shall be provided.

Components shall not be secured by means of self-tapping screws.

Lock washers shall be used on all screws.

Circuitry

Panel Supplies

An 'on-load' multi-pole isolator capable of isolating the supply to the panel shall be provided.

A 'panel alive' indicator lamp shall be provided.

Where a supply to components is required independent of the panel isolator or a supply is fed back into the panel from another source, the components and associated wiring shall be housed in an earthed metal enclosure. The front of the enclosure carrying a label stating 'danger', the voltage present and the source of the supply in red letters on a white background.

Control Circuits

Each group of control circuits shall be supplied via a separate fuse and have a 'control circuit fuse failed' indicator lamp.

Each starter shall be provided with one or more of the following control circuits as specified: -



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3-wire control circuit for use at line to neutral voltage but with links to facilitate use on 2-wire control. The circuit shall be complete with control fuse and neutral link.

An intrinsically safe control circuit to BS 1259 and BS 5501: Parts 7 and 9 arranged for 3-wire control but with links to facilitate use on 2-wire control. The circuit shall be complete with control fuse and neutral link.

A test switch within each starter enclosure to facilitate testing the contactor mechanism and control system without applying power to the motor.

Start/bypass buttons on the front panel with terminals and links for use with remote bypass/start station and/or remote latch out 'emergency stop' station.

Motor Circuits

Each motor supply circuit shall be provided with HRC fuses. Each motor circuit incorporating a star-delta starter shall be provided with a remote lockout isolation circuit.

Each motor circuit shall be provided with 'starter closed' and starter tripped' indicator lamp shall be via an auxiliary contact on the starter. The supply for the 'starter tripped' indicator lamp shall be controlled by an auxiliary contact on the overload device.

Where duplicate motors are required for a single function a selector switch shall be provided to select the motor required and ensure that only that motor can be in operation.

When automatic starting of a second motor on the 'tripping' of the first is required, a selector switch shall be provided to select the motor to be first in line.

Where the switching on of a number of motors together may cause a supply fuse to fail, timers shall be provided to stagger the switching on.

Panel Wiring

Wiring shall be PVC-insulated and adequately rated.

Wiring shall be suitably colour coded according to circuit.

Multi-strand conductors shall be used where flexing of wire is expected.

The radius of bends in wires shall be not less than the manufacturer's recommended value.

Long runs of wiring shall be adequately supported, the supporting arrangement not causing permanent physical damage or deformation to the conductors or insulation. Where practical, wiring shall be run in such a manner that it can be checked against diagrams without removing supports.

Wires shall not be laced.

Where wires pass through metal structures or structures liable to cause damage, insulated grommets or bushes shall be used.



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All wiring for control and power circuits shall be segregated.

All wiring shall be segregated from pipework containing steam, water, oil and the like.

Earthing

An earth terminal shall be provided.

Each component shall be suitably earth bonded.

Where equipment is mounted on a separate frame a flexible tinned copper braid shall interconnect the frame and the earth terminal.

A separate flexible tinned copper braid shall bond each door to the panel.

Surfaces of all equipment to which earthing connections are made shall be cleaned free from paint and other non-conducting material.

Terminals

Terminals shall be of an adequate rating and identified in accordance with the wiring diagram.

Pinch type terminals shall not be used.

Outgoing circuits shall be brought to terminals adjacent to the point of cable entry, this position being specified.

Spares

Three spare fuses for each rating of fuse shall be provided and clipped inside the panel.

Three spare indicator lamps shall be provided and clipped inside the panel.

Testing

All wiring and earth bonding shall be tested for continuity and correct identification with the wiring diagram.

All wiring shall be tested for insulation to earth.

Thermocouple circuits shall have their polarity proved.

Protection of Panel

Each panel shall be protected against damage during transit, storage, erection, commissioning and testing. Any damage shall be made good at no expense to the Client.

Drawings

Graphical symbols shall be in accordance with the current BS EN 60617.

The following drawings shall be submitted for approval before manufacture commences: -



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- Circuit diagram.
- Panel arrangement.
- External wiring connections.

A copy of the wiring diagram shall be provided on laminated plastic material within each panel.

CONTACTOR STARTERS

Starters shall comply with BS EN 60947-4-1 and BS 5856 for auto-transformer and the like and be suitable for the mechanical and electrical duty specified. All enclosures shall be primed and finished to an approved BS colour.

Each starter shall be provided with an isolating switch capable of making and breaking the stalled current of the controlled motor and shall be in accordance with BS EN 60947-3. Contactors shall comply with BS 5424 and BS EN 60947-4-1. In addition the isolator shall have the facility of being able to be locked in the “OFF” position. Where required additional poles shall be provided for connection into auxiliary circuits such that the starter interior shall be completely isolated from all supplies upon operation of the switch.

When required starter enclosures shall be fitted with an anti-condensation heater. The heater shall be designed to operate on line to neutral voltage and the circuit shall be taken from the ‘live’ side of the line isolator to the control circuit neutral. The heater fuse shall be of the insulated withdraw able type housed in the isolator compartment and marked ‘heater fuse’. The heater and its lead shall be fully shrouded to enable maintenance work on the starter to be carried out in safety whilst the heater is still ‘alive’. A warning label reading ‘heater circuit alive’ shall be visible when the cover is open.

PROTECTION AND METERING

Each starter shall be provided with one or more of the following protective devices as specified: -

3-pole overload and single phasing protection by means of a thermal relay, hand resetting pattern with automatic adjustment for ambient temperature changes.

Over current trip coils operating in conjunction with fluid dashpot time lags.

Inherent ‘no-volt’ release feature.

3-pole overload, instantaneous earth fault and single-phasing protection by means of a thermal protection relay.

Instantaneous earth fault relay with flag indicator, core balance current transformer operated.

3-pole thermostat protection relay.

Short circuit protection on each phase by an HRC cartridge fuse to BS 88 and BS EN 60269.



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STARTER METERING

Where required starters shall be provided with an ammeter arranged for full load reading between half and three-quarters full-scale reading. A line indicating the full load current of the motor shall be marked in red on the scale.

The ammeter shall be designed in accordance with BS EN 60051. Where required starters shall be fitted with an 'hours run' indicator on the cover of the instrument.

Current transformers and voltage transformers for use with protective devices and measuring instruments shall conform to the requirements of BS 7626 and BS 3941 respectively.

LOOSE EQUIPMENT

Each separate item of equipment supplied loose, such as thermostat pulling motor and motorised valves, shall be clearly identified with its function and position, with screwed on traffolyte labels.

WIRES, CABLES AND FLEXIBLE CORDS

The type of insulation, number of cores, size of conductors and sheathing will be specified by the controls engineer.

PVC AND VR INSULATED CABLES

Unarmoured PVC and VR insulated cables shall be protected by conduit or trunking.

Conductors shall not be wrapped round stud terminals, crimped lugs, applied with a tool specifically designed to prevent inadequate crimping shall be used to connect cables to stud terminals. Care shall be taken to ensure that the cable insulation is not trimmed back beyond the lug.

FLEXIBLE CORDS

Cables subjected to high temperatures shall be one of the following: -

Butyl in silicone rubber.

Mineral insulation.

Flexible cords shall be of the 300/300V grade or 300/500V grade to BS 6500, the type of insulation being suitable for the working temperature.

WIRES AND CABLES

The following standards shall apply: -

BS 6004 PVC-insulated cables (non-armoured) for electric power and lighting.

BS 6007 Rubber insulated cables for electric power and lighting.

BS 6207 Mineral insulated cables Part 1 - copper conductors, copper sheathed. PVC orange covered.



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- BS 6231 PVC-insulated cables for switchgear and control gear wiring.
- BS 6346 PVC-insulated cables for electricity supply.
- BS 6480 Impregnated paper insulated cables for electricity supply Part 1 - lead or lead alloy sheathed cables for working voltages up to 33kV.
- BS 5467 XLFE insulated cables for electricity supply.
- BS 6724 LSF insulated cables for electricity supply.

Note. The specification and installation of all equipment in other sections of this specification shall also apply to this section.

TESTING AND COMMISSIONING

The whole of the automatic controls installation shall be tested and commissioned by the controls engineer to the entire satisfaction of the services engineer.

AUTOMATIC CONTROLS SYSTEM – GENERAL OVERVIEW

The mechanical Contractor shall include for the supply, installation, inspection, testing, commissioning, setting to work, instruction and leaving in working order of all automatic control systems.

This work shall be carried out by a single specialist controls company who shall be responsible for providing all of the equipment necessary to complete the whole works.

In addition the following requirements must be complied with.

This description of operations indicates the requirement for the location of control panels for the mechanical services installation and the controls specialist shall comply with all of these requirements.

The range of controls equipment provided shall be fully compatible with each other, and where necessary the appropriate interfaces shall be provided.

The controls specialist shall be responsible for carrying out all site revisions as necessary to the controls installation to provide the full description of operations specified.

The controls specialist shall include for all power and control wiring between all loose sensors, valves etc and the associated controllers/control panels.

The automatic controls installation shall incorporate all equipment necessary to provide the specified description of operations and this requirement shall be deemed to have been included as part of the mechanical services tender. In addition, the supply and installation of all field wiring (control signalling and power) associated with the automatic controls installation, i.e. between control panels, mechanical equipment and control sensors, shall be included as part of these works. The electrical service Sub-Contractor shall provide electrical power to the following: -



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- Main Control Panel located within the plantroom.

All electrically operated actuators shall be provided to suit air dampers, having torque ratings adequate for the purpose. Actuators shall also be provided for valves as necessary. Thermostats, sensors, etc. shall be provided as necessary to suit the characteristics of the equipment being controlled. Motorised control valves shall be selected such that the pressure drop across the valve is kept to a minimum and for 3-port valves controlling heat exchangers the pressure drop shall match that of the pressure drop across the coils to ensure a valve authority of 0.5.

Where airflow and water flow failure sensors are specified these shall be of the pressure differential type and anti-flutter timers shall be included. Unless otherwise stated the starters for all mechanical services equipment shall be housed within the control panels.

All star-delta starters shall be provided with a control feed such that the isolation of the motor via the local isolator will break the control feed, such that the motor will restart in 'star' connection.

CONTROL PANELS – GENERAL ARRANGEMENT

The control panels shall be constructed in accordance with the general specification section included within this document.

Notwithstanding this, each control panel shall be constructed and designed such that the components are segregated internally into two compartments, each being accessible via independent doors.

One compartment shall house all controls components (110V maximum) with all 240V single-phase and 415V 3-phase supplies being housed within the second compartment. An internal dividing screen shall separate the two compartments strictly in accordance with the standard specification.

High Voltage Compartment

Access to the 240/415V compartment shall be as follows: -

Lockable hinged doors.

Door interlocked isolator.

Hinged polycarbonate screens in accordance with the standard part of the controls specification.

Apertures for test purposes shall be provided as necessary in accordance with the standard part of the controls specification.

Low Voltage Compartment

Access to the low voltage (110V) compartment shall be by means of lockable-hinged doors. All controls equipment located within this section shall be suitable for a voltage not exceeding 110V.

STAGGERED START OF EQUIPMENT

Each control panel shall incorporate staggered start facilities such that a call for equipment to operate, either on timeswitch or following isolation of the panel, the plant shall start in progressive stages such



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that at each panel a load of not more than 15kW is introduced at each stage. If a single item of plant is rated at more than 15kW then only this one item of plant shall start at any one time.

BUILDING MANAGEMENT SYSTEM

General

The control of the mechanical plant shall be undertaken by a main control panel located within the plant room.

Automatic Controls System

All electrical power and control wiring including containment systems associated with the automatic control system shall be carried out by the specialist controls Sub-Contractor who shall provide a fully packaged contract/installation.

Overview

A Trend based front end PC supervisor shall enable an operator to view the status and values of all inputs and outputs connected to the BMS. This will enable the operator to make valid, economical decisions on the efficient automatic operation of the mechanical services plant in order to maintain the required environment for the occupants within the building.

The supervisor shall provide the user with a Windows based operating system (Trend 963) using spreadsheets and databases to collate information from the outstation relevant to the efficient use of the plant.

The supervisor shall also be provided with a monitor to allow graphical representation of plant status and performance. A printer will be provided to register plant alarms and the generation of trend logs for the assessment of plant efficiency.

The operating software installed on the supervisor terminal shall enable a competent operator, via a security code, access to the following information and functions: -

Alarm Status

Indication of plant fault or temperature alarms. An Alarm shall indicate the status of each alarm active or inactive to be reset via simple acknowledgement commands.

Control Functions

- Proportional, Integral and Derivative control of analogue output device
- Self-adaptive optimum start and stop schedule
- Frost protection.
- Plant protection during shutdown.
- Sequential plant starting.



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- Load cycling.
- Energy efficient plant schedules.

Measured Values

All input and output measurements, analogue or digital shall be provided with identification labels and utilised for monitoring purposes.

Time Clock Control

View or change selected plant-operating schedules, manual operation and date exemption programs. The operator shall have the facility to start or stop any individual items of plant from the operator terminal.

Set point Adjustment

View and adjust selected set points and parameters from on screen menus.

Event Logging

Interval and time span user-defined logs shall be generated from data on the network. The controls specialist shall allow two working days in order to liaise with facilities management in order to create logging and reporting functions.

Totalisation

Plant run time totalisation inclusive of run time limits with alarm generation outside of normal parameters. Hours run data shall be collected to a database of common format capable of being exported to Microsoft Excel or a PPM system.

Graphics

Dynamic colour graphics shall be generated to represent schematically the plant installed, displaying set points, measured values, overriding facilities and alarms.

FORM 2 CONTROL PANEL

The power section shall contain an internal shrouded bus bar with appropriately sized fuses and switchgear for the mechanical services plant as listed below.

- Gas solenoid valve.
- LPHW pressurisation unit.
- LPHW heating boiler No. 1
- LPHW heating boiler No. 2
- DHW Generator No. 1
- LPHW heating pump No. 1



- LPHW Heating Pump No.2
- DHWS Return pump No. 1
- Booster Set No. 1
- BMS control section
- VRV Condenser No. 1
- VRV Condenser No. 2
- AHU No. 1
- AHU No. 2
- Ceiling Void/Wall mounted Air Handling Equipment

A door interlocked isolator shall be provided for isolation of all power circuits in order to enable safe maintenance and access with the exception of fused power supplies to the gas solenoid valves and the fire alarm interlock relay which shall be separately fused and shrouded.

The fascia of the power section shall be provided with plant selector switches and plant status indicators.

The BMS outstation power supply shall also be derived from the live side of the door interlocked isolator and provided with a local isolator inside the control section.

The fascia shall also be provided with panel live and control circuit healthy indicators and an indicator test facility.

The control section shall include all necessary software, hardware, operator input and output interfaces required for the complete operation of the mechanical building services plant.

The fascia of the control section shall be provided with an IQ View operator's keypad to interrogate the controllers within the building.

The IQ View shall be capable of password protection and shall enable the user to make alterations to plant time and temperature settings and monitor devices connected to the BMS outstation.

SENSING/CONTROL DEVICES

The control unit shall monitor plant operation status and control by the following control / sensing devices:

- Outside air sensor
- Boiler No. 1 flow sensor
- Boiler No. 1 return sensor
- Boiler No. 2 flow sensor



- Boiler No. 2 return sensor
- Plant emergency stop signal
- Gas meter (in external enclosure)
- Water meter (incoming)
- Pressurisation unit trip status
- 2No. Thermal Links
- Fire Alarm
- 2No. Boilers
- 1No. DHW Generator
- LPHW circulation pump
- DHWS secondary return pump No. 1
- Domestic hot water flow temperature sensors
- Domestic hot water secondary return temperature sensors
- MCWS Storage tank level sensor
- MCWS Storage tank temperature sensor
- VRF Controller run/fault

All items of mechanical plant shall be linked back to the BMS and shall have as a minimum on/off scheduling facility and common fault alarm signal.

FIRE ALARM INTERFACE

A hard-wired interface with the building fire alarm system shall be provided adjacent to the control panel in order to shut down the mechanical plant with the exception of the boiler primary pump.

The plant shall be configured to automatically restart once the fire condition has been cleared.

The power section of the control panel shall provide a permanent 24v AC supply to the fire alarm interface. The fire alarm interface shall provide a normally open contact held closed in the normal situation, this configuration shall facilitate a fail-safe operation.

GAS SOLENOID VALVE

An electrical power supply to the gas solenoid valve located within the plant room shall be provided from the live side of the control panel isolator and shall be maintained by all of the following interlocks: -



Thermal link/cut out above the boiler/s.

The emergency shut off button located in close proximity to the plant room door.

An interlock with volt free contacts from the building fire alarm system.

A gas solenoid valve closed indicator shall be provided on the control panel fascia. The gas solenoid shall open automatically when the interlock has been re-established.

LOW PRESSURE HOT WATER HEATING PLANT

The heating plant comprises of the following components: -

1 No. Gas solenoid valve

2 No. Gas fired heating boilers

1 No. Twin headed heating primary pump

1 No. Twin headed constant temperature flow pumps

1 No. Pressurisation unit

All the items listed above with the exception of the gas solenoid valve are located within the plant room.

BOILER CONTROL

A power supply for the boiler shall be provided from the control panel.

The boiler plant shall be enabled by any of the following demands: -

Optimum start signal from the main controller to a maximum of two hours prior to the scheduled start time.

The frost protection routine from any controller.

A boiler return water immersion temperature sensor installed within a ½ “BSP pocket located in the common return pipe work shall be monitored by the BMS in order to provide the frost protection function.

An immersion sensor in a ½ “BSP pocket located in the common flow pipe work shall monitor the boiler flow temperature.

The boilers shall be fully operational during the optimised start period.

Upon achieving the set primary return temperature the control system shall revert the boiler/s to cascade control.

The control system shall then compare the measured primary return temperature with the control set point. The control system shall then sequentially stage on and off the boiler modules to maintain the set return temperature.



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A hand/off/auto selector switch shall be provided for each boiler on the control panel fascia. In the hand mode the boiler will operate continuously and under the dictates of the main controller in the Auto position. Indicators shall be provided on the control panel fascia for each boiler, showing if it has been enabled, and when a lockout or high temperature fault has occurred.

Each boiler shall be provided with volt free contacts for connection to the control system to indicate a common fault.

The boilers shall be disabled in the event of any of the following: -

- Primary pump flow failure.
- Pressurisation unit fault.
- Gas solenoid valve closure.
- Fire alarm activation.

PRESSURISATION UNIT

A permanent electrical power supply shall be provided and maintained to the pressurisation unit from the control panel. In the event of either of the high or low-pressure switches exceeding the operating setting of the unit a fault indicator will show on the control panel fascia and a fault alarm signal shall be raised at the BMS display unit and the heating pumps shall be disabled until the fault is cleared.

A supply 'ON' indicator shall also be provided on the control panel fascia. The pressurisation unit shall be provided with volt free contacts for connection to the control system to indicate a fault status via a common fault alarm.

LPHW PRIMARY/BOILER PUMPS

The pumps shall be enabled by any of the optimum start time schedules or via the frost protection program within the BMS.

The duty pump shall be alternated every week to ensure even usage of the pumps.

An indicator fault lamp shall be illuminated on the control panel fascia should a flow failure condition exist.

A timer shall overrun the pumps at the end of any occupancy period in order to dissipate the residual heat in the boilers and prevent lockout. The boiler primary pumps shall be maintained until the flow temperature drops below 55°C at the end of an occupancy period or in the event of a fire alarm.

A hand/off/auto and pump 1/pump 2 selector switches and individual Run/Trip indicators shall be provided on the control panel fascia. In the hand mode the pump selected on the pump 1/pump 2, selector switch shall operate continuously and under the dictates of the main controller in the auto position. The pump 1/pump 2, selector switch shall only be effective in the hand position.

A differential pressure switch installed across the pumps shall monitor the flow condition during normal operation. In the event of a flow fail condition a Flow Fail lamp shall indicate on the control



panel fascia and an alarm shall be displayed on the BMS. The BMS shall monitor the flow status of the differential pressure switch for one minute to ensure that the failure is not due to turbulence or an unorthodox operation of the duty pump. After the failure-proving period, if the flow has not been established the BMS shall automatically latch off the duty pump and enable the standby pump. In the event of a flow not being proven when the standby pump is enabled the standby pump shall be retained in case the flow failure is due to a faulty differential pressure switch. The BMS shall not attempt to re-enable the duty pump.

A pump auto-changeover reset button shall be provided on the control panel fascia and connected to the BMS. The button shall be operated after the faulty pump(s) have been replaced in order to enable the run/standby sequence and restart the selected duty pump.

Hand position monitor alarms shall be provided to generate an alarm via the BMS should any of the heating circulators be left running in the hand position for more than twenty minutes.

In the event of a failure an alarm shall generate a fault.

COMPENSATED FLOW/HEATING PUMPS

Compensated flow pumps shall provide the required mass flow rate of water against the frictional resistance of the circuit.

The pumps for each compensated zone shall be enabled by an independent optimum start time schedule or the frost protection program within the BMS.

The operation of the pumps shall be as the boiler primary pumps but with no run on in the event of a fire alarm or at the end of an occupancy period.

COMPENSATED HEATING/MIXING VALVES

The required compensated heating temperature in each zone shall be provided by a modulating motorised 3 port mixing valve controlled by the BMS.

Each valve shall be fully open during the optimised start period and modulate throughout the day dependant on external weather conditions.

The valve shall be controlled by the BMS in order to provide a compensated flow temperature of between 75°C at an outside temperature of -1°C and 20°C when the temperature outside has risen to 20°C.

The ratio for the compensation shall be 3:1 where the mixed flow temperature shall rise by 3°C for every 1°C decline in the outside air temperature.

An immersion water temperature sensor shall be installed within a ½" BSP pocket in the mixed flow pipe-work serving each zone after the pumps and an outside air temperature sensor on a north wall shall be connected to the BMS in order to provide the compensated heating control.

A space/room sensor within each zone shall be utilised to provide additional room trim to the final compensated set point.



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An immersion water temperature sensor in the flow pipe-work, after the pumps, in each system and the outside air temperature sensor on a north wall shall be connected to the BMS in order to provide the compensated heating control.

CONSTANT TEMPERATURE PUMPS

Constant temperature pumps shall provide the required mass flow rate of water against the frictional resistance of the circuit.

The pumps for each constant temperature zone shall be enabled by either the start time schedule or the frost protection program within the BMS.

The operation of the pumps shall be as the boiler primary pumps but with no run on in the event of a fire alarm or at the end of an occupancy period.

BUILDING FROST PROTECTION

The hydraulic heating circuit shall be automatically protected to prevent frost freezing of the various pipework circuits. This shall be achieved over three stages as follows: -

STAGE 1

In the event of the ambient temperature falling to 1°C or below the control system shall be arranged to run all the LTHW pumps to circulate water through the system until the outside temperature rises to above 2°C. In addition, all the associated control valves shall also be opened to allow full flow through their respective circuits.

STAGE 2

In the event of the water temperature within the primary flow or return pipework to the boilers falling to 5°C or below the heating plant shall be enabled in order to circulate low-pressure hot water and prevent any possibility of freezing. This stage shall be disabled when the return water temperature rises by 5°C to 10°C.

STAGE 3

In the event of the temperature within the building falling to 10°C or below, during periods when the plant is not operating, then stages 1 and 2 will operate irrespective of their individual conditions, to ensure the building fabric and contents are protected from condensation.

OPTIMUM START

The compensated heating systems shall be enabled by their own independent optimum start time schedule. The designated optimum start time shall be dependent on the internal space temperature within the compensated zone and the outside air temperature sensor. However the optimum start time shall not initiate more than two hours prior to the scheduled start time.



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The BMS controller shall enable the compensated LPHW plant at the latest possible time in order to bring the space temperature within the building to the required set-point (typically 28°C) by the start of the scheduled occupied period.

The outside air temperature sensor shall be located on a north-facing wall or shielded from any possible solar gain.

C1.2.15. PROVISION OF ALL THERMAL INSULATION TO PIPEWORK AND DUCTWORK.

The Contractor shall include for the installation of thermal insulation to all pipework systems in accordance with the particular section of this specification and the drawings.

Close attention shall be given to co-ordinating the mechanical installation equipment with other services and structural restraints to enable insulation to be applied completely and separately to all individual pipes and ducts etc.

All insulated services shall be identified by colour banding and labels with flow direction arrows applied, all conforming to British Standards.

The Contractor shall allow for acoustic insulation to be provided preventing the break-in and break-out of noise to and from mechanical plant in sensitive areas which would otherwise result in specified area noise levels not being achieved.

The Contractor shall ensure that adequate provision is made to include the following minimum requirements:

- LTHW Pipework and vessel lagging.
- Trace heating to all water systems, where at risk from freezing.
- Identification labels, system names, flow direction arrows, valve labels, plant identification labels.
- Insulation and/or vapour seals shall not be cut to facilitate the installation of other services.
- HWS generators and pipework lagging.
- Cold water pipework systems.
- Water leak detection to tank rooms and adjacent to all pump sets.

C1.2.16. TESTING, COMMISSIONING, AND DEMONSTRATION OF MECHANICAL SERVICES

The contractor shall carry out full testing, commissioning and demonstration in accordance with Part C25 of the specification.



C1.2.17. OPERATION AND MAINTENANCE MANUALS AND RECORD DRAWINGS

At handover the contractor shall provide 3Nr sets of operation and maintenance manuals complete with as installed record drawings.

The Contractor shall include for the provision of all Operating & Maintenance Manuals together with record drawings, manufacturers literature, plant operating procedure descriptions, plant maintenance instructions, all as set out in this specification.

Four weeks prior to Practical Completion, or Partial Possession of the Works, two copies of a Draft Maintenance Manual shall be submitted to the Services Engineer for examination and comment. (Manufacturers literature and Record Drawings shall not be required at this stage.)

Following receipt of final comments from the Services Engineer, and upon Practical Completion, of the Works, one copy of the approved Maintenance Manual shall be provided and handed to the Services Engineer, and two copies of the main contractor.

Each manual shall be of the loose leaf A4 size type, having a rigid cloth bound cardboard cover, subdivisions for each section, a ready means of reference and a detailed index. The text for the front cover shall be submitted to the Services Engineer for comments in a timeous manner to allow submission of the final copies of the manuals.

Each manual shall contain full operating and maintenance instructions for each system and item of equipment included in the Works.

The paper used in the final documents shall be of good quality high white 120 g/m² and the reproduction method shall be dry photocopy.

The arrangement of the Maintenance Manual shall be as follows:-

Section 1 - General Index

This section shall contain the Index, for the entire content of the manual.

Section 2 - Systems Operation

This section shall contain a description of each system, its operational intent, and a schedule of the parameters used as a basis for the design of that particular system.

Section 3 - System Operation and Set Points

This section shall contain a description of operational routines, which includes procedures to be followed to 'start up and 'shut down' items of plant, and how to undertake various testing procedures (e.g. Earth Continuity Test) and fault finding. A schedule of set point control settings for normal operation of each system shall also be included.

Section 4 - Planned Maintenance Instructions



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This section shall contain a description of Planned Maintenance Instructions, for all systems and each item of plant and equipment, and must include step-by-step instructions, to supplement the manufacturer's literature.

This section shall contain manufacturer's literature. Relevant equipment data only shall be extracted from the manufacturer's literature and included within these documents. Literature which contains descriptions of equipment which is of no concern to the end user, shall not be included.

Where equipment is non-standard, information for the Maintenance Manual shall be obtained from the manufacturer.

A full legend for the colour coding and all services.

Section 5 - Schedule of Plant and Equipment

This section shall contain a full schedule of all plant and equipment, including duty, electrical load, flow rates, and the like where applicable.

Section 6 - Commissioning Results

This section shall contain a full set of the commissioning results for each system, presented in a format which is easily understandable and which contains equipment and valve references which relate exactly to references noted on the installation and record drawings.

Originals of the following documentation shall be provided:-

Main Plant and Testing Commissioning Sheets

Chemical Cleaning Certificates

Chlorination Certificates

I.E.E. Inspection and Completion Certificates

Manufacturers Test Certificates for Specialist Equipment (i.e. booster)

Section 7 - Spares

This section shall contain comprehensive list of spare parts and materials as proposed and agreed with the Services Engineer.

Section 8 - Emergency Procedures

This section shall describe actions to be undertaken in the event of an emergency, and shall include a full directory of names, addresses and telephone numbers of individuals, or organisations (as agreed with the Services Engineer) to be contacted.

This section shall also include a description of the basic principles of First Aid.



Section 9 - Index of Record Drawings

This section shall contain an Index of all Record Drawings produced, indicating their numbers and titles.

Section 10 - Computer Disc

This section shall contain a CD containing a complete copy of the operating and maintenance documentation, excluding manufacturer's literature, in Microsoft Word format, for transferring into an 'IBM' or compatible computer word processing package.

C1.3 DETAILS OF EXISTING SERVICES & EQUIPMENT

1. General

The details of all existing services, included in this documentation and as shown on tender drawings are provided for information purposes only.

The responsibility for checking and verifying the precise location of all services rests entirely with this section of the works.

Any damage to services and any consequential damage created as a result of damage to services caused by this section of the works, shall be the responsibility of, and completely rectified at the expense of this section of the works.

Claims for want of knowledge in this regard will not be entertained.

2. Existing equipment and services.
3. Re-routing of existing services.
4. Breaking into existing services.
5. Diversions.
6. Enabling Works.
7. Temporary Works
8. Removal of existing equipment and services and other redundant materials.
9. Existing equipment re-used.
10. Fire precautions in existing buildings.
11. Any other items which are considered to be of special importance to the Tenderer.
12. Existing asbestos insulation.
13. Existing insulation.



C1.4 BUILDERS WORKS IN CONNECTION

1. Trial holes to locate MCWS in car park.
2. Provide trench for new gas main and back fill
3. Box in pipework where shown on tender drawings
4. Provide openings in roof for flues and vents as shown on tender drawings
5. Provide holes in walls for local ventilation fans.
6. Provide frames/skids as necessary for external condensers and air handling units.
7. Provide support in stud wall for wall mounted AC cassettes.



PART C - SECTION 2 LOW TEMPERATURE HOT WATER HEATING

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PART C - SECTION 2

LOW TEMPERATURE HOT WATER HEATING

C2.1 GENERAL

Where applicable, the installation shall comply with BS 6880 : Parts 1, 2 & 3, BS EN 12828, BS EN 12831 and BS EN 14336.

C2.2 PIPEWORK AND FITTINGS

Pipes of nominal sizes up to and including 125mm shall be of mild steel to BS EN 10255 heavy quality. Pipes of larger sizes shall be seamless carbon steel to BS 3601 (Grade 320) having the following minimum wall thicknesses:-

Nominal Pipe Sizes mm	Wall Thickness mm
150 to 200	6.3
229 to 300	8.0

Pipes and fittings in circulating systems shall have black finish.

Unless otherwise specified, all mild steel pipework shall be assembled using welding fittings to BS EN 10253-1 and BS EN 10253-2, of the same thickness as the pipe, and shall be jointed by welding in running lengths, except in occupied area pipework which is 50mm and below. Changes in direction shall be accomplished using long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements use easy transition type with included angle not exceeding 30°. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.

Pipework visible in occupied areas (other than plantrooms) up to and including 50mm shall be assembled using malleable cast iron screwed fittings to BS EN 10242 Design Symbol A. Elbows and swept tees shall be used.

Screwed joints shall be to BS 21 and made using jointing materials and compounds and hemp to BS 4504 or BS EN 1092 as appropriate or PTFE tape to BS 7786.

Final connections to air conditioning terminal units (fan coils, VAV units, and the like) plus all other pipes and fittings (cold feeds, open vents, drains, overflows, and the like) shall be copper to the requirements of BS EN 1057 R250, assembled with tin/copper pre-soldered capillary type fittings to BS EN 1254, using bends and square tees.

Pipework branches to terminal units in false ceiling voids shall be taken from the side or top of the main unless otherwise specified and shall be laid to fall to vent via the terminal units.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves and the like which are not provided with flanges or unions and, where necessary, in the pipework system to allow for easy erection and dismantling of the installation.



Maintenance joints shall be positioned where they will be accessible on completion of the Contract. Maintenance joints in circulating pipework up to and including 50mm nominal sizes, and in connections to equipment with screwed ends shall be malleable iron unions having taper threads to BS 21. Unions in low pressure installations shall have spherical bronze to iron seats and in medium pressure installations shall have spherical bronze to bronze seats.

Flanged maintenance joints shall be used in circulating pipework of nominal sizes greater than 50mm and in connections to equipment with plain ends. Flanges used for maintenance joints shall be carbon steel boss welding type to BS 4504 or BS EN 1092 : PN10, as appropriate. Flanges used for connections to flanged equipment, valves, and the like shall match the flanges provided on the equipment. All flanged joints shall be made with full faced brass corrugated joint rings coated on both sides with jointing compounds all to BS 4504 or BS EN 1092, as appropriate. Bolts, nuts and washers shall be black steel, complying with the requirements of the same British Standard and Pressure Rating as the flanges being connected.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Pipes shall be thoroughly cleaned before erection. Six screwed or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory, the six joints shall be reassembled, if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between any service and a service or building element shall be as follows, after allowing for thickness of any insulation:-

<u>Between</u>	<u>And</u>	<u>Clearance</u>
Uninsulated or insulated pipework :	Wall, ceiling or soffit :	100mm
	floor :	150mm
Insulated pipework :	Adjacent service (insulated) :	25mm
Insulated pipework :	Adjacent service (uninsulated) :	75mm
Uninsulated pipework	Adjacent service (uninsulated) :	150mm

During erection, open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Except where exposed in rooms, pipework shall be fitted at a gradient of not less than 1 in 250.

Thermal expansion of pipework shall be absorbed by expansion loops, sets or bellows units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction, whether or not indicated on the drawings. Where necessary, bends shall be incorporated in connections to equipment and in branch connections in mains. Cold draw shall be applied to all expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe. Expansion loops and bellows up to and including 50mm shall have welded or screwed ends. All other expansion loops or bellows shall have flanged ends.



Pipework supports shall allow free axial and/or lateral movement to suit the expansion system employed, except where anchor or guide brackets are utilised. Pipe anchors shall be constructed to withstand the maximum forces exerted during thermal expansion and contraction, and during pressure testing. Guide brackets shall be rigidly secured and provide free movement for axial expansion without undue lateral tolerances.

Pipework visible in rooms shall be supported in accordance with BS 1494 on black malleable iron brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the built-in type having properly formed shanks. For thinner walls or partitions, screw-fixing brackets shall be used, secured with black steel screws by means of expanding plugs, fibre or metal plugs, or purpose designed fixing devices where appropriate. Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards.

Pipework in other locations shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angles or channels shall be accurately drilled to the correct size.

In certain instances a small pipe may be suspended from a larger pipe, the reverse will not be allowed.

Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
15	1.8	2.5
20 & 25	2.5	3.0
32	2.8	3.0
40 & 50	3.0	3.7
65 & 80	3.7	4.5
100	4.0	4.5
125 & 150	4.5	5.5
200	5.0	6.0
250 & 300	6.0	7.0

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

For supports where pipework is insulated see Clause Pipework & Ductwork Supports - Part C - Thermal and Acoustic Insulation.



In order to prevent stress fractures occurring in valves and fittings, all materials and components used on the low and medium temperature hot water heating system shall be confirmed by the manufacturer to be suitable and compatible with the operating temperatures, fluids, and other components of the system. Brass fittings and components should not be used. Acceptable materials would include Copper Alloy, DZR Alloy and Gunmetal.

C2.3 VICTAULIC TYPE FITTINGS (Low Temperature Hot Water System Only)

Unless otherwise specified, all mild steel pipework shall be assembled using fittings of the same thickness as the pipe being, Victaulic grooved fittings or Victaulic shouldered fittings to BS EN 10253-1 AND BS EN 10253-2 : Part 1, and shall be jointed by Victaulic couplings or welding in running lengths, except in occupied area pipework which is 50mm and below.

Changes in direction shall be accomplished by using either long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter or Victaulic short radius elbows.

For reductions and enlargements easy transition type with included angle not exceeding 30° shall be used. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.

All victaulic fittings shall have a black finish.

Pipework visible in occupied areas (other than plantrooms) up to and including 50mm shall be assembled using Victaulic fittings to BS 6681.

Final connections to air conditioning terminal units (fan coils, VAV units, and the like) plus all other pipes and fittings (cold feeds, open vents, drains, overflows, and the like) shall be either Victaulic Coparite or copper to the requirements of BS EN 1057 R250, assembled with tin/copper pre-soldered capillary type fittings to BS 864 : Part 2, using bends and square tees.

When the thermal expansion cannot be incorporated within the working limits of the Victaulic joint then the thermal expansion of pipework shall be absorbed by expansion loops, sets or bellows units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction, whether or not indicated on the drawings. Where necessary, bends shall be incorporated in connections to equipment and in branch connections in mains. Cold draw shall be applied to all expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe. Expansion loops and bellows up to and including 50mm shall have welded or grooved ends. All other expansion loops or bellows shall have flanged, Victaulic grooved or Victaulic shouldered ends.

Joints for all metallic pipework shall be provided with the means for electrical continuity within the pipework system in accordance with the current IEE Wiring Regulations.

C2.4 EXPANSION JOINTS

All expansion joints shall be supplied and installed in accordance with the manufacturers instructions and be complete with all necessary guides, anchors and hangers.

Axial movement shall be compensated for by the installation of expansion bellows. Expansion bellows shall have welded or screwed joints up to and including 50mm and flanged joints above. Expansion bellows shall be manufactured from stainless steel with stainless steel inner sleeves and outer protective sleeves.



Lateral movement or vibration shall be compensated for by the installation of braided lateral movement or anti-vibration joints. These shall have welded or screwed joints up to and including 50mm and flanged joints above. Lateral movements or anti-vibration joints shall be manufactured from stainless steel bellows with stainless steel braiding.

Where expansion joints are installed in areas where the temperature is higher than normal ambient temperature, precautions shall be taken when setting expansion bellows to allow for contraction when the system is filled.

In order to reduce the forces in the pipework when heated each expansion joint shall be sprung open when being fixed cold (cold drawn) by an amount equal to 40% of the total of each joint, care being taken to see flanges do not 'cup'.

C2.5 ANTI-VIBRATION PIPE SUPPORTS

In plant rooms all pipework shall be supported from a bracket arrangement incorporating a suitable spring vibration isolator.

C2.6 VALVES

Valves shall comply with the following British Standard Specifications for the temperature and pressure of the installation:-

Description	British Standard
Radiator Valves	BS 2767
Cast Iron Wedge and Double Disc Gate Valves	BS EN 1171
Cast Iron Parallel Slide Gate Valves	BS 5151
Cast Iron Globe and Globe Stop and Check Valves	BS EN 13789
Cast Iron Check Valves	BS 5153
Copper Alloy Wedge, Double Disc & Parallel Slide Gate Valves	BS 5154 Series B
Copper Alloy Check Valves	BS 5154 Series B
Copper Alloy Globe Valves	BS 5154 Series B
Butterfly Valves	BS EN 593
Diaphragm Valves	BS EN 13397
Cast Iron Plug Valves	BS 5158
Cast Iron Ball Valves	BS ISO 7121

Valves shall be installed in the flow and return connections to all heat emitting units and elsewhere as specified and/or indicated on the drawings.



Valves of nominal sizes, 50mm and less shall have ends screwed to BS 21 Taper Thread. Larger valves shall have flanged ends complying to BS 4504 or BS EN 1092 as appropriate and be similar to those selected for the pipework installation.

Isolating valves shall be provided with wheel handles and regulating valves shall be of the Lockshield type unless locking facilities are provided on the valve. Where Lockshield models or locking facilities are not available, the wheel handle shall be removed after regulation, and handed over to the person appointed to operate the installation. Three keys shall be provided for each size of Lockshield valve installed.

Valves of 54mm/50mm and less which incorporate flat face washer type connections shall not be installed on any system.

Valves shall be installed in positions which permit easy access for operation and maintenance but shall not be installed where a leaking gland may drip on electrical equipment. Gate valves shall preferably be installed with stems horizontal. Unions incorporated in or fitted adjacent to screwed valves shall be positioned on the "system" as opposed to the "boiler" side of the valve.

Valve ends shall be sealed at works and the sealing left intact until immediately before installation in the pipeline. Chromium plated valves shall be protected from damage throughout the Contract period, and the chromium plating shall comply with BS EN 12540.

Flow and pressure measurement valves shall be located to ensure the manufacturers recommended straight length of pipe upstream and downstream of valves is provided.

C2.7 DRAIN COCKS

Drain cocks shall be installed on all items of equipment and at all low points in the pipeline system and adjacent (within 250mm) to valves isolating sub-circuits to enable the whole, or sections of the system, to be drained down.

Drain cocks installed in the pipework system shall be of 15mm nominal size. Drain cocks at the foot of risers and in Plant Rooms shall be 25mm nominal size. The sizes of other drain cocks are specified with the equipment concerned.

Drain cocks shall be copper alloy of the screwdown pattern to BS 2879. Each drain cock shall have inlet end screwed to BS 21 taper thread, ribbed outlet end suitable for hose attachment and lockshield type head. Three lockshield keys shall be provided for each size of drain cock installed.

Drain cocks shall be fitted clear of pipe insulation and in positions allowing easy operation of the handles.

C2.8 AIR ELIMINATORS

Air eliminators shall be suitable for the operating temperature of the particular system in which they are installed and be mounted on air bottles installed at all high points in the pipework system.



Manually operated eliminators shall be 8mm nominal size nickel plated copper alloy, spoutless, lockshield type air cocks, with inlet ends screwed to BS 21 taper thread. Air cocks shall be fitted in easily accessible positions, extension pipes being provided where necessary between the connections on the mains and the air cocks. Extension pipework shall be of 8mm nominal size copper tube to BS EN 1057 R220, assembled with capillary fittings to BS EN 1254. In all cases air cocks shall be arranged to discharge clear of pipe insulation. A total of six air cock keys shall be supplied.

Automatic air eliminators shall be of the float-operated type, having aluminium bronze bodies and stainless steel working parts, 15mm nominal size inlet connections screwed to BS 21 taper thread, and be complete with separate lockshield valve and strainer on inlet. Air release pipes shall be run from the outlet connections to discharge in an external position or in a location where water discharge would not result in damage to the building fabric (e.g. adjacent a plant room floor gulley). Air release pipework shall be of 15mm nominal size copper tube to BS EN 1057 R250, engraved with manufacturer's name and BS number and assembled with capillary fittings to BS 864 : Part 2. Automatic air eliminators shall be installed in positions which permit easy access for maintenance.

Air bottles shall be made from 200mm lengths of 50mm nominal size pipe having inlet connections of 50mm or mains size, whichever is the smaller.

C2.9 THREE WAY ESCAPE VALVES AND COCKS

Three way escape valves and cocks shall be of full bore construction of the same nominal size as the vent pipe in which it is installed, and shall be designed to maintain an escape route between the inlet port and either, or both, of the other two ports at all positions of the operating handle.

Escape valves and cocks shall have copper alloy bodies and working parts and have ends screwed to BS 21 taper thread. Valves shall be provided with wheel handles and have renewable discs. Cocks shall be of the gland pattern and have removable wrench-type handles. A drainpipe shall be run from the drain port of each valve or cock, to terminate 200mm above finished floor level, and be of the same nominal size as the vent pipe. The drain pipe shall be of copper tube to BS EN 1057 R250, assembled with tin/copper pre-soldered capillary fittings to BS EN 1254, and be adequately supported.

C2.10 TEMPERATURE MEASUREMENT

Provision for temperature measurement in the pipework system shall be made by installing thermometer pockets and thermometers.

Pockets shall be copper alloy screwed to BS 21 and shall be of length and diameter to suit the bulbs of the specified thermometers. Each pocket shall be installed in the pipework at a suitable angle to enable a fitted thermometer to be easily read from floor level, and in such a manner as to provide adequate circulation over the full pocket length. Where necessary, cross pieces of minimum 50mm nominal size shall be installed in the pipework to accommodate the pockets. The entrance to each pocket shall be positioned clear of pipe insulation.

All thermometers shall be mercury in steel direct-mounting type, having a straight rigid bottom entry stem suitable for use with the specified pockets. Dials shall be 100mm diameter calibrated 0-120°C.



Where thermometers are permanently fixed, the gap between thermometer bulk and pocket shall be fitted with suitable oil or grease. Empty pockets shall be fitted with copper alloy screwed plugs.

C2.11 PRESSURE MEASUREMENT

Provision for pressure measurement in the pipework system shall be made by installing gauge connectors and pressure gauges.

Each gauge connector shall comprise a short branch from the main terminating with a gauge cock. Branches shall be sufficient length to clear pipe insulation. Gauge cocks shall be of copper alloy with lever handles and ends screwed to BS 21 to suit the connections on the specified pressure gauge. Each connector shall be arranged to allow a fitted pressure gauge to be easily read from floor level.

All pressure gauges shall be direct mounting bottom inlet Bourden Tube type, complying with BS 1780 and BS 5235 and having 100mm diameter dials, calibrated in bar to between 1.5 and 2 x the maximum working pressure in the system. Each pressure gauge shall be provided with an adjustable red pointer which, in the case of the permanently mounted gauges, shall be set to indicate the normal working pressure at the point in the system. Where fitted in pressure vessels, clearly mark with maximum permissible working heads in accordance with BS 759.

Pressure gauges shall have casings and dials of the same style and finish as thermometers.

C2.12 CIRCULATING PUMPS

Pumps shall comply where appropriate with BS 1394 : Part 2 and BS 5257 according to type, size of pump, pressure and temperature conditions.

Pumps having screwed ends shall be BS 21 taper thread and those with flanged ends shall be to BS 4504 and similar to those selected for the pipework installation. Where pump ends are of smaller nominal size than connecting pipework, eccentric reducers shall be installed immediately adjacent to the pump, and all valves, strainers, and the like shall be of the same size as the main line connecting pipework.

Each pump shall be driven by an electric motor and each motor shall be controlled by a speed controller and automatic starter. See Clause headed 'Motor Control Gear' contained within Part 'C' - Electrical.

Each pump and motor shall be correctly aligned and efficiently balanced to minimise vibration. Drive belts, where fitted, shall be properly tensioned.

All pumps shall be installed with suitable anti-vibration equipment between the pump and the building fabric to prevent the transfer of vibration. This shall apply to floor-mounted, wall-mounted and pipeline-mounted pumps.

Floor-mounting pump units shall be mounted on suitable inertia anti-vibration bases and be complete with flexible pipe connections. Pipework connections shall be arranged and supports provided to prevent transmission of pipeline forces into the pump casings.

Wall mounted pumps shall be installed using proprietary or purpose designed fixing brackets, to enable anti-vibration mountings or alternative anti-vibration material to be installed (e.g., Tico-pads).



Pipeline-mounting pump units shall be supported by means of brackets fitted in the pipeline adjacent the suction and discharge connections. Supports within 3.0m of each pump unit shall be lined with 'Tico Clip Strip' or similar vibration absorbent material.

Pumps which incorporate packed stuffing boxes shall be fitted with drain pipes run from the connections provided to discharge into the nearest gully. Drains from groups of pumps may be collected into a 150mm diameter copper tundish, and a common drain run to the discharge point. Drain pipework shall be of 22mm nominal size copper tube to BS EN 1057 R250, assembled with tin/copper pre-soldered capillary fittings to BS 864 : Part 2. To facilitate cleaning, use plugged tees instead of elbows.

Dual pump sets, comprising two pumps fitted in parallel as a packaged unit, shall have screwed or flanged ends, and each set shall incorporate an automatic flap valve to prevent recirculation through the stationary pump. Each dual pump set shall be supplied with a blanking-off plate and gasket to allow closure of either volute casing when motor and impeller are removed.

Where a duplicate pump set comprises two pumps connected in series, a short piece of pipe of the same nominal size as the pumps shall be supplied. This pipe shall be cut to length, screwed or flanged to suit, and arranged to fit in place of either pump should one be taken out of circuit.

A gauge connector, with fixed pressure gauge, shall be sited in the suction and discharge connections to each pump, or each pair of duplicate pumps.

Before handover, bearings shall be maintained in good condition by lubricating to the manufacturer's recommendations and (except for glandless pumps), by rotating pump and motor shafts daily.

Each pump shall be subjected to an hydrostatic test pressure at the manufacturer's works, of not less than 1.5 x the maximum working pressure. A Test Certificate shall be provided for each pump, certifying that it has been subjected to the specified hydrostatic pressure, that it performs to the type, test, duty and, where applicable, that it complies in all respects with BS 1394 : Part 2 and BS 5257.

Each pump shall be selected to ensure that the specified duty is not on or close to, or at the top or close to the top of, a particular performance curve.

Each installed pump shall have a body and impeller which is capable of handling an increase in pressure which is a minimum of 15% above the specified total pressure at the design volume.

The motor of each installed pump shall have a size/rating which is a minimum of 15% greater than that required for the selected unit body and impeller.

For belt driven pumps, note should be taken of the Clause headed 'Belt Driven Equipment' contained within Part 'B' of this Specification.

Notice should be taken of the Equipment Selection Clause contained within Part B of this part of this Specification, which requires a margin on all motors at the specified duty.



C2.13 UNIT HEATERS

Each heater shall be fitted with steel headers or copper with solid drawn copper tubes fitted with copper or aluminium fins expanded over the tubes having pipe connections flanged to BS 4504 or BS EN 1092 as appropriate. Drain cocks and isolating valves shall be fitted to all heaters.

Suspension eye bolts shall be fitted to the heater with internal bracing to provide adequate support without strain or distortion on the casing. Suspension type heavy steel brackets shall be supplied and fixed to the steel structure and walls with the eye bolts positioned to suit the location of suspension brackets.

Each heater shall be fitted with extended casings to totally enclose the fan and motor. Those heaters which are fitted with fresh air inlets shall be provided with extended inlets fitted with steel angle flanges to facilitate connection of the ductwork. Heaters without fresh air inlets shall be fitted with heavy wire guards with quick release fastenings.

Casings on all units shall be constructed to permit unrestricted access to the batteries for cleaning and maintenance.

Adjustable curved louvres shall be fitted to the heaters. Motors shall be totally enclosed, continuously rated, suitable for operation with the water temperature stated and wound for the electric supply available. Lubrication nipples shall be extended through the casing tops to approved positions. Starters shall be provided with the equipment. Fans shall be rated to deliver the air volumes against the resistance of the ducting system.

Louvres shall be adjusted to give the correct distribution during testing and regulating.

Test Certificates shall be provided for the heaters confirming pressure tests and thermal output ratings and air volumes.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.

Each heater shall be fitted with an individual number and label.

C2.14 CONVECTORS (NATURAL)

Natural convectors shall be rated in accordance with BS EN 442.

Air venting of each convector element shall be performed through airlet plugs fitted at the manufacturer's works so that air venting may be performed without having to remove the inspection panel. Air vent plugs must not protrude clear of the heater cabinets.

Each convector shall have top and bottom grilles with damper control fitted to each top grille and be of the floor or wall mounting pattern.

Each convector shall be provided with the manufacturer's standard sheet steel liner constructed to fit neatly around the element to form an air duct and obtain maximum stack effect to guide the cooler air through the element and direct the warmed air forward through the discharge top grille. Each liner shall be provided with adjustable element support brackets to allow adjustment for grading the element to vent through the airlet plug.



Each heater casing and front plate shall be completely de-rusted prior to dispatch from the manufacturer's works and after de-rusting shall be coated with a suitable primer. Where necessary, further treatment and priming shall be carried out on site to prepare the surfaces for decorative painting.

Each convector casing shall be securely supported to the building structure in a suitable manner and shall incorporate insulation material between the rear casing and building structure where specified.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.

C2.15 RADIATORS

Radiators shall be manufactured and rated in accordance with BS EN 442 and shall bear the British Standards Institution 'Kitemark'.

Each radiator shall have screwed connections to BS 21 taper thread and airlet plug or 3mm air cock.

Radiators to be installed against walls shall be fitted to give a manufacturer's minimum clearance from the wall. Radiators fitted on outside walls shall be fitted with reflective panels.

The number of bottom brackets and top stays shall be in accordance with the manufacturer's recommendations.

Valves for radiators shall be installed with their axis vertical.

Each radiator shall be taken down and refixed twice after the initial installation to allow for plastering and painting the walls.

Radiator top shelves shall be supplied and fixed on all radiators which are not fitted directly below windows.

Radiators shall be completely de-rusted prior to dispatch from the manufacturer's works and shall be finished with a metallic primer. Where necessary further treatment and priming shall be carried out on site to prepare the surfaces for decorative painting.

Unless otherwise specified, radiators shall be bottom/bottom/opposite end connections.

C2.16 MECHANICAL CONVECTOR HEATERS

The duties shall be calculated in accordance with BS 3528. Each heater casing shall be supplied with all necessary inspection panels, inlet and outlet grilles with suitable seals and fixing screws.

Each heater shall have a sinuous coil non-ferrous finned tube heating element with screwed connections, super-silent flexibly mounted electric motor directly driving centrifugal casing fan runners, and a washable type filter.

Air venting of the heater batteries shall be arranged through airlet tapplings provided on the heating elements, complete with copper pipes and air cocks so that they can be operated from outside the casing without having to remove inspection panels.



Remote convectors with ductwork shall have the grilles and spigots fixed to suitable timber frames.

Electric switches shall not be incorporated in the convectors unless otherwise specified.

Heaters shall be supplied complete with built-in thermostats or shall be supplied with loose thermostats for remote fixing. Each heater shall be complete with all internal electric wiring between the terminal block and motor and, where provided, built-in thermostats.

Each heater shall be fitted with a thermostat fitted into the return connection of the unit, to interrupt the operation of the fan when the water temperature falls below an agreed set point level. Where the heater is served from a compensated heating circuit, the thermostat shall be suitable for the depressed temperature of the circuit.

Each heater casing and its access panels shall be completely de-rusted prior to the dispatch from the manufacturer's works, and after de-rusting shall be coated with a suitable primer. Where necessary, further treatment and priming shall be carried out on site to prepare the surfaces for decorative painting.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.

C2.17 FEED AND EXPANSION TANKS

Each tank shall be adequately stayed to prevent distortion and be complete with the bosses tapped female to BS 21 taper pipe thread.

Unless specified otherwise, metal tanks shall not be used. Tanks shall be polythene, polypropylene or GRP.

Polythene or polypropylene tanks shall comply with BS 4213 with all connections formed on site and adequately stayed at the ball valve connection to prevent distortion.

Polythene or polypropylene tanks shall be supported evenly across the whole base area.

Each tank shall be provided with a ball valve to BS 1212 : Part 1, adjusted so as to maintain a depth of water not exceeding 150mm in the tank when the system is cold. To achieve this in large tanks the standard arm shall be lengthened by the addition of a suitable non-ferrous bar brazed onto existing arm ends. The extension piece shall be of equal cross section to existing arm.

A copper overflow and warning pipe, shall be arranged to discharge in an external position. The overflow pipe shall be turned down inside the tank terminating 50mm below the water line.

Each tank shall be fitted with a 25mm drain cock, as detailed under the Drain Cock clause included within this section of the Specification.

Each tank shall be complete with a suitable loose cover, in sections, with turned down edges and handles.

All tanks shall be thoroughly cleaned out prior to commissioning.

All tanks shall be insulated as detailed within the Thermal & Acoustic Insulation section of this Specification.



All connections shall be of sufficient length so as to project clear of the finished face of the tank insulation to facilitate ease of disconnection.

All tanks shall comply with the Water Regulations.

Each tank shall be clearly labelled as to its function i.e., 'Heating Feed and Expansion Tank'.

C2.18 OPEN VENT (NATURALLY VENTED SYSTEMS)

An open vent shall be taken direct from each boiler or calorifier and connected to a common open vent installed between the plant chamber and the feed and expansion tank, the end of the pipe being turned down to discharge over the tank.

The pipework material and fittings shall be as described in the 'Pipework and Fittings' clause of this section of the Specification.

Under no circumstances must any obstruction be placed in any section of the open vent pipework other than the 3-way escape valve.

C2.19 COLD FEED (NATURALLY VENTED SYSTEMS)

A cold feed connection shall be installed from the feed and expansion tank and connected to each boiler or calorifier. The pipework material and fittings shall be as described in the 'Pipework and Fittings' clause of this section of the Specification.

The outlet from the feed and expansion tank and the cold feed inlet to each boiler or calorifier shall be provided with an isolating valve, complete with locking device and open and shut indication.

C2.20 DIRT SEPARATOR & DEAERATOR

Where specified, a line size combined dirt separator and deaerator shall be installed in the main flow pipe leading from the boiler plant.

Units of nominal sizes 32mm and below shall have ends tapped to BS 21. Units 40mm and above shall have flanged ends complying to BS 4504 : PN16.

Isolating valves shall be installed on either side of the dirt separator/deaerator, and the dirt/drain outlet.

Full bore drain pipework in copper to BS EN 1057 R250 assembled with tin/copper pre-soldered capillary fittings to BS 864 : Part 2, shall be run from the dirt/drain connection of each unit, and terminate to discharge 300mm above the nearest gully.

C2.21 FLUSHING, CLEANING & TREATMENT OF WATER SYSTEM

Each system shall be flushed and cleaned in accordance with the principles laid down in the BSRIA Application Guide 1/2001.1 entitled 'Pre-Commission Cleaning of Pipework Systems'.



All recommended reporting procedures, and progressive recording for the flushing, cleaning, and treatment of each system shall be provided as part of this section of the works. A detailed method statement covering the cleaning and flushing process, including coloured schematic drawings illustrating the dynamic flushing flow paths similar to those detailed in the Application Guide shall be provided to the Services Engineer prior to the commencement of the cleaning process. The method statement shall be discussed with the water treatment specialist prior to Tender and any additional equipment, valves and the like, required to comply with this Application Guide 1/2001.1 shall be provided as part of this section of the works.

Chemical cleaning shall be carried out using a suitable cleaning agent incorporating a polymer/dispersant and an inhibitor. This solution shall be circulated around the system for a minimum of 12 hours.

The selected chemicals shall be capable of controlling all corrosive, aggressive and bacteriological agents contained within the water to be used within the system.

Particular attention shall be given to local water conditions, and this section of the works shall include the responsibility to control all adverse conditions including pseudomonas.

Where required by the Local Water Authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

Following Local Water Authority approval, either neutralise and dispose to drain off all waste products, or ensure authorised disposal at registered site.

After flushing and cleaning the complete installation, comprising all pipework, tanks, cisterns and other equipment connected to the Cold Water Supply System, shall be efficiently sterilised before handover.

Sterilisation shall be carried out by the Specialists to the requirements of BS 6700. The sterilisation Specialists shall be informed of all constituent materials in the system, to ensure that suitable chemicals are selected. On completion, the system shall be thoroughly flushed out to remove all traces of sterilising chemicals.

C2.22 RELIEF VALVES

Relief Valves shall be the spring loaded totally enclosed type, set to discharge at the safe working pressure of the system, calculated in accordance with the formula in BS 759.

Each valve shall be fitted with a drain pipe lead to discharge near floor level, which is provided with a suitable support at the terminal point. The drain pipe shall be of equal bore to the valve.

To prevent the setting of the valve from being interfered with, the enclosure shall be fitted with a padlock supplied with duplicate keys.

C2.23 STRAINERS

One strainer shall be installed within the main return header of each system, before all automatic control valves and pumps and in other locations as shown on the drawings.

Strainers shall have brass or stainless steel screens with 0.8mm perforations, equal to not less than three times the normal bore of the pipe.



Strainers shall be installed in conjunction with local isolating valves to enable the screen to be removed whilst cleaning is taking place.

Strainers 50mm size and below shall be of bronze construction and those above shall be of cast steel construction.

Strainers 100mm size and above shall be fitted with an integral drain cock to facilitate drain down prior to screen maintenance i.e., between local isolating valves.

Strainers shall have connections compatible with the pipework specification, be installed in the horizontal plane and between two valves which can be isolated, and as described elsewhere in this specification.

Strainers having screwed ends shall have threads complying with BS 21.

C2.24 CHECK VALVES

Super sensitive check valves shall be the full size of the service pipe into which they are installed.

Check valves 50mm size and below shall be of bronze construction and those above shall be of cast steel construction.

C2.25 PRESSURISATION UNITS

Pressurisation units shall be provided capable of providing a constant minimum heating unit/system pressure whilst maintaining a relatively constant system water content compensating for any minor leaks. Where specified, each unit shall be complete with standby pump with duty sharing and automatic changeover facilities.

Each unit shall be fully automatic incorporating high/low pressure cut out switches, visual indication, control pressure switches, feed tank and ball valve and suitably sized expansion vessels. It should be noted that 3 tiers of pressure control shall be provided on both the high and low pressure conditions. The three tiers shall be:- 'control', 'remote warning' and 'trip'. Only the trip condition shall shut down associated plant, in accordance with the Automatic Controls system.

Each unit shall be positioned in the system as indicated on the drawings and shall incorporate an accumulator vessel and pressure reducing valve to avoid erratic pump operation.

Each pressurisation cylinder provided as part of a pressurisation unit shall be selected such that each unit/system volume expansion from ambient temperatures to operating temperatures can be accommodated within the vessel, and within the specified pressures, without the need for water discharge, or make up for the system.

A replaceable diaphragm membrane shall be provided between the water and the air within the expansion vessel.

Under no circumstances shall any obstruction i.e., isolating valve or NRV be placed in the pipework between each pressurisation unit expansion cylinder and the heating unit/system to which it is connected.



The pressurisation unit shall be fully packaged and pre-wired requiring only an electrical supply and control alarm circuits to be fully operational. The integral controls shall incorporate facilities for indication of high pressure and low pressure alarm, pump run and trip both on the control panel forming part of the unit and for remote indication.

The cold water connection to each unit shall incorporate a type 'A' air gap.

C2.26 EXPANSION VESSELS

Where a pressurisation unit provides the system working pressure, a suitably sized expansion vessel shall be connected to the cold feed connection to each heating unit, or each group of heating units.

Each expansion vessel shall be capable of handling the expansion volume of its associated heating unit when the heating unit is working at its maximum capacity and be capable of withstanding the maximum test pressure of the system.

Each expansion vessel shall be complete with a replaceable diaphragm, pressure gauge, and finished in a high standard gloss paint.

Any isolation valves installed in the pipework linking the expansion vessel to the heating unit shall be complete with padlock and chain and a warning notice 'valve must be in the open position'.

C2.27 UNDERGROUND PRE-INSULATED PIPE SYSTEM

The underground mains system shall be supplied, installed and pre-insulated in accordance with BS 7572, generally in standard lengths of approximately six, twelve or sixteen metres, and shall be as a pipe-in-pipe system utilising high grade steel tubes to R-ST37.2 DIN 17100/2458/1626/3 wrapped with a primary insulation of mineral wool and insulated with polyurethane foam in a case of first class, high impact, rigid polythene tube to DIN. 8075.

The whole of the system shall be suitable for the working hot water temperature of the system.

All joints on the inner steel tube pipework forming the complete underground mains system shall be welded and the welds tested to 1.5 times working pressure or 14 bar hydraulic, whichever is the greater.

This pressure shall be maintained without loss for a minimum period of two hours. Installation welders shall hold an approval certificate to BS EN 1418 and BS 4871 and/or BS EN 287, BS EN ISO 15607, BS EN ISO 15610 and BS EN ISO 15611.

Radiography testing shall be made on five out of the first ten welds made by each operator, and 10% of all subsequent welds carried out. After welding, all steel joints shall be wire brushed before insulation and closure are applied.

Heat shrunk water barriers shall be provided at each building entry to prevent water penetration into the insulation.



All site closure joints shall be insulated with a primary insulation of pre-formed mineral wool with either:-

- (a) Pre-formed sectional polyurethane foam inserts
- or
- (b) Site dispensed, in situ foam utilising an aluminium or steel former

The insulation shall then be covered with a sheet of bitumen (which shall overlap the insulation) and finally be encased with a durable plastic shrink sleeve. Where the plastic shrink sleeve joins the outer casing, secondary shrink sleeves with bitumastic backing shall be shrunk as a double seal to the outer casing joints.

Each jointing kit shall consist of the following :-

- (a) A pre-formed primary insulation section of mineral wool, and either; a split, pre-formed section of polyurethane insulation for insulating the gap left by the welding ends
- or
- an aluminium or steel former and nylon clamps for site dispensed in situ foaming of the gap left by the welding ends,
- and
- a bitumen wrap to act as a water seal for wrapping around the insulation so as to overlap each end on to the polyethylene casing.
- (b) a primary shrink sleeve to give mechanical and corrosion protection, which is placed to completely cover the bitumen wrap.
- (c) two secondary shrink sleeves lined with a bitumastic sealant placed at each end of the primary sleeve to give further mechanical and corrosion protection.

All fittings shall be of a quality equal to the standard lengths of pipe, be pre-insulated at Works and tested before despatch.

Underground mains isolating valves shall be maintenance free, stainless steel ball construction, pre-insulated for delivery to site to maintain integrity of the system and prevent the possibility of ingress of moisture.

All tubes and fittings shall be supplied with the ends of the insulation sealed with heat shrink water barriers to prevent damp conditions from deteriorating the polyurethane. Tube and fittings shall be delivered to site with plastic end caps over all steel pipe ends. Insulation sections shall be delivered in plastic bags for protection against weather conditions.

Expansion shall be taken up by the use of bellows or by the provision of special expansion fittings at changes in direction.

The expansion fittings shall be insulated by a high density, soft polyurethane foam to ensure that the outer casing is subjected to minimum expansion stresses, and this soft foam shall completely fill the annulus between the service pipe and outer casing to ensure no air gaps occur.

At all points of entry buildings, the pre-insulated pipes shall terminate approximately 200mm above the finished floor level.



An insurance backed guarantee covering the installation for a period of five years, shall be submitted to, and for acceptance by, the Services Engineer.

C2.28 SELF-SEALING TEST POINTS

Self-sealing test plugs shall be provided as follows together with additional test plugs where indicated on the drawings or elsewhere in this particular specification.

- Three off - adjacent to each three port control valve.
- Two off - adjacent to each circulating pump.
- Two off - on the flow and return connections to each LTHW calorifier (primary and secondary), or each boiler.
- One off - main flow connection to each 3 port control valve/battery. In this application with the valve in the return, the flow test point must be on the system side of the by-pass, to ensure accurate part load duty assessment. As a general rule the test point shall be fitted on the constant volume side of the valve, or in a position not influenced by the by-pass mixing effect. The same rationale shall apply to thermometers and temperature sensors.

One thermometer and one pressure gauge suitable for use with the test plugs shall be packed in a protective casing and handed to the Services Engineer on completion together with an adequate supply of any necessary insertion lubricant. Plugs shall be fitted with captive caps for sealing them when not in use and the plugs shall have internal self-sealing devices. The plugs and probes shall be manufactured from materials suitable for the application.

C2.29 GAS FIRED BOILER PLANT

Unless otherwise specified, atmospheric gas fired boiler plant shall be provided and shall be constructed to withstand the working pressure of the system and shall incorporate a draught diverter and a burner assembly suitable for use with natural gas.

The burners shall comply with the gas regulations and shall comprise of main burner, pilot burner, gas valves, constant pressure governor, safety gas shut off valves and thermo-couple flame failure devices. Burners shall be of a low Nox design.

Each boiler unit shall be controlled by a suitable thermostat built into the control box, and an overriding manual reset high limit thermostat.

Thermal insulation shall be fitted and shall comprise 50mm thick reinforced aluminium foil faced glass fibre quilt as a minimum.

Each boiler module shall be provided with the following mountings,

- 1 No. safety valve complete with lifting lever, padlock and key, and a copper discharge pipe, as detailed in the Clause headed Three Way Escape Valves & Cocks, run to terminate 200mm from floor level. Unless otherwise stated the safety valve shall be set to operate at a pressure of 70 kN/m² above working pressure and be of the soft seat type.
- 2 No. Self sealing test points.
- 1 No. 25mm nominal size drain cock as detailed in the clause headed Drain Cocks shall be installed at lowest point of the module.



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When erected in position and prior to the application of the insulation and the fixing of casings, each boiler and associated pipework shall be tested to 1½ times the working pressure for a period of 2 hours.

The boiler casings shall not be fitted until the work of all trades is complete in the boiler house. In the event of it being necessary to fire the boilers before completion of the work, precautions shall be taken to protect the casings, as damaged casings will not be accepted.

Boiler efficiency shall be fully compliant with the requirements of the Building Regulations. Where specified or where required to be compliant with Building Regulations, condensing boilers shall be utilised. Materials of boiler construction shall be fully suited to the condensing application.

A competent Services Engineer shall check the boiler installation and associated wiring, and shall commission the boiler in accordance with the manufacturer's instructions.

C2.30 FLUE HEADER AND CHIMNEY

Each boiler or combustion appliance shall be provided with a suitable flue system. Where multiple boilers/appliances are provided, individual flue systems, or a common flue header and chimney shall be provided.

Common headers shall pass to vertical chimneys terminating above the ridge of the building. Each vertical chimney serving gas fired boiler plant shall terminate with a British Gas approved terminal incorporating a bird screen. Each vertical chimney shall be supplied and installed strictly in accordance with the Clean Air Act requirements pertaining to sulphur bearing fuel.

Each flue pipe and chimney shall be constructed from materials that are durable, compatible and will not cause galvanic action on any part of the flue and chimney assembly. Joints shall be of the twist lock or ring clamp type and shall form a gas tight joint.

The inner lining and outer casing shall each have rolled form or hemmed ends. The inner and outer pipe shall be seamed together at the made end, leaving the inner casing free to expand.

Both flue pipe and vertical chimney shall incorporate insulation between the inner and outer casing.

Where the vertical chimney passes through a floor, the space shall be fire stopped at each level. The flue system shall be installed a minimum of 50mm from any combustible materials.

Each flue pipe and chimney shall be adequately supported from the building structure, independently of the boilers, and the base of a floor mounted vertical chimney shall incorporate a 2mm thick mild steel support plate adequately bolted to the floor.

An easily removable clean out access door incorporating handle shall be provided at the base of the vertical chimney and at the end of the flue header within the Boilerhouse. The base of the chimney shall incorporate a 20mm drain which shall be run to the outside of the building. The drain shall be manufactured from copper tubing and shall incorporate a water trap.

All exposed metalwork other than stainless steel or aluminium shall be painted in accordance with Part 'B' of this Specification.



Where the flue system is utilised in conjunction with condensing boilers, the flue material, construction, and jointing method shall be fully suited to the condensing application, designed for corrosion resistance, and to allow condense to drain back to a drain point at the base of the chimney.

Where a room sealed/balanced flue chimney system is installed, the whole of the system shall be installed fully in accordance with the manufacturer's recommendations, and using their components throughout.

C2.31 OIL FIRED BOILER PLANT

Oil fired boiler plant shall incorporate pressure jet burners, suitable for operation with Class 'D' fuel oil to BS 2869.

Each boiler unit shall be controlled by a suitable thermostat built into the control box, and an overriding manual reset high limit thermostat.

Thermal insulation shall be fitted and shall comprise 50mm thick reinforced aluminium foil faced glass fibre quilt as a minimum.

Each boiler module shall be provided with the following mountings,

- 1 No. Safety valve complete with lifting lever, padlock and key, and a copper discharge pipe, as detailed in the Clause headed Three Way Escape Valves & Cocks, run to terminate 200mm from floor level. Unless otherwise stated the safety valve shall be set to operate at a pressure of 70 kN/m² above working pressure and be of the soft seat type.
- 2 No. Self sealing test points.
- 1 No. 25mm nominal size drain cock as detailed in the clause headed Drain Cocks shall be installed at lowest point of the module.

When erected in position and prior to the application of the insulation and the fixing of casings, each boiler and associated pipework shall be tested to 1½ times the working pressure for a period of 2 hours.

The boiler casings shall not be fitted until the work of all trades is complete in the boiler house. In the event of it being necessary to fire the boilers before completion of the work, precautions shall be taken to protect the casings, as damaged casings will not be accepted.

A competent Commissioning Engineer shall check the boiler installation and associated wiring, and shall commission the boiler in accordance with the manufacturer's instructions.

Unless indicated otherwise and in order to counteract the potential for back end corrosion, each boiler shall be fitted with a shunt pump arrangement as recommended by the boiler manufacturer.



C2.32 CONTROL VALVE SELECTION

3-way control valves whether used in either the diverting or mixing application, shall wherever possible be selected to ensure the valve does not impose a resistance on the system of more than 15 kPa. However, the over-riding factor in control valve selection shall be valve authority, and as a general rule, a valve authority of 0.5 shall be the governing factor.

In 2-port valve situations control/authority is more complex, and sizing of these valves shall be based on the individual system hydraulics, as described in the CIBSE Automatic Controls Applications Manual.

Control valve selections shall be notified to the services engineer for review.

C2.33 FLEXIBLE HOSES

Where equipment is connected via flexible hose connections, these should have quick connect/self sealing connections.

Flexible hoses shall be in full accordance with BSRIA Code of Practice 11/2002, having a guaranteed service life of at least 10 years and be rated to 10 Bar pressure.

Where hoses are required in an application of high temperature ($>110^{\circ}\text{C}$) for a prolonged period, then metal hoses shall be used having a minimum service life of 25 years.

C2.34 UNDERFLOOR HEATING SYSTEMS

Low pressure hot water underfloor heating systems shall be supplied by a firm specialising in these systems, and having a minimum of 10 years experience in providing these systems in both commercial and domestic applications.

The underfloor heating system shall incorporate the following components, being provided by the specialist firm as part of the underfloor heating system package:

- Heating pipework
- Manifold
- Circulation Pump
- Thermostatic Control Equipment

The underfloor heating pipework shall be a multi-layered polyethylene pipe, continuously laid, complete with 100% efficient oxygen diffusion barrier. Pipework is to be complete with a 40 year guarantee, and shall be fully compliant with the relevant ISO and DIN standards. The pipe shall be laid fully in accordance with the underfloor heating specialists recommendations in terms of fixings, insulation, spacing, pipe bending radii, and acceptable floor coverings. The underfloor heating specialist shall provide full and comprehensive details of the associated builders work that will be required for the satisfactory installation of the heating pipe. The underfloor heating system shall be installed by the specialist, or under supervision of the specialist. Before the pipework is covered over, a Certificate of Conformity shall be issued by the specialist to confirm that the system has been satisfactorily installed.



The underfloor system shall be complete with a manifold, circulating pump and temperature control, provided either independently or as a 'package'. Two stage temperature control (control and safety cut-out) shall be provided to control the temperature of the water flow into the underfloor heating circuit(s), in accordance with the particular application, via a mixing valve, and a shut off valve. Control and safety temperature settings shall be selected to suit the application in question (i.e. the make-up of the floor) and the heating output/design criteria. Reset of the safety shut-off shall be by manual means.

Each area of underfloor heating system shall incorporate a room sensor, for temperature control of the space, via the manifold system.

The manifold shall incorporate temperature gauges on the flow and return out to the underfloor heating circuits, and self-seal test points and isolation valves on the heating connections into the manifold system.

Water treatment inhibitor selected for the heating system shall be of a type suitable for use with the underfloor heating system materials (and in consideration of other materials utilised on the heating system).

Specialised underfloor heating systems using conventional LPHW temperatures of 80°C flow may be considered, where the heating pipes used employ an insulated outer pipe, but only with the approval and agreement of the engineer. Where this system is being considered, full and comprehensive technical details shall be provided to the engineer for review.



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PART C - SECTION 4

STEAM & CONDENSATE

C4.1 GENERAL

Where applicable, the installation shall comply with the requirements of BS 806, BS 1306 and BS ISO 8501-3.

C4.2 PIPEWORK AND FITTINGS

Steam pipework installations comprising pipes and fittings between outlet connections on boilers and inlet connections to steam condensing equipment, steam using equipment and steam main drain assemblies shall be of black finished steel.

Pipes of nominal sizes up to and including 125mm shall be of mild steel to BS EN 10255 heavy quality. Pipes of larger sizes shall be seamless carbon steel to BS 3601 (Grade 320) having the following minimum wall thicknesses:-

Nominal Pipe Size mm	Wall Thickness mm
150 to 250	6.3
300	8.0
350 to 450	9.5

Pipework up to and including 25mm nominal size may incorporate screwed joints, where these will be readily accessible on completion of the Contract. Screwed pipes shall be taper threaded to BS 21 and screwed pipework shall be assembled with black wrought steel fittings to BS EN 10241, and joints shall be made with graphite manganese jointing compound. All other pipework shall be assembled by welding and welded pipework shall be installed in accordance with 'Recommended Practice and Tests for Certificates of Competency for Oxy-Acetylene and Metal Arc Welds in Mild Steel Pipework', issued by the Heating and Ventilating Contractors Association. Welded pipework up to and including 125mm shall be assembled with heavyweight seamless steel butt welding pipe fittings to BS EN 10253-1 and BS EN 10253-2. Welded pipework 150mm and above shall be assembled with seamless steel butt welding pipe fittings of the same thickness and grade as the tube being jointed.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and, where necessary, in the pipework system to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible on completion of the Contract.

Maintenance joints in screwed pipework shall be wrought steel unions to BS EN 10241, having spherical steel to steel seats. Long screws shall not be used.

Flanged maintenance joints shall be used in welded pipework and flanged joints shall be used for connecting all equipment, valves, and the like into welded pipelines. Equipment with screwed ends shall have carbon steel screwed boss flanges screwed on and the pipe ends expanded into the flanges using a roller expander.



Other pipe ends shall be flanged using carbon steel boss welding flanges. Flanges used for connections to flanged equipment, valves, and the like shall match the flanges provided on the equipment.

All other flanges shall be to BS 4504 or BS EN 1092 as appropriate. All flanged joints shall be made with corrugated brass joint rings coated on both sides with jointing compound all to BS 6956 or BS EN 751-1 as appropriate. Bolts, nuts and washers shall be black steel, complying with the requirements of the same British Standard and Pressure Rating or Table as the flanges being connected.

Changes in direction shall be effected by the use of elbow fittings or by bends formed from pipe. Pipe bends up to 50mm nominal size may be cold pulled on site but larger bends shall be hot formed in the factory. Pipe bends shall show no reduction in the pipe bore and the throat shall be free from ripples. Minimum centre to end shall be 1.5 nominal pipe size.

Wherever practicable branch connections shall be made using tee fittings or branch bends for welding. Branches shall be taken from the top of steam mains.

Reduction in pipe size shall be effected using eccentric reducing fittings or formed eccentric taper pieces; bushes shall not be used.

All pipes, manufactured bends and fittings shall be cleaned internally at Works to the requirements of. After cleaning, ends shall be sealed and the sealing left intact until immediately before erection. On removal of the seals all parts shall be checked for internal cleanliness. During erection, open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Six screwed or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory, the six joints shall be reassembled: if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between the surface of a pipe or its insulation and finished building surfaces or other pipes or insulation shall be 25mm except for pipes exposed in rooms where 100mm minimum clearance shall be maintained between the pipe surface and the finished surface of the floor.

Pipework shall be fitted at a gradient not less than 1 in 250. The fall shall, where practicable, be in the direction of flow.

Thermal expansion of pipework shall be absorbed by expansion loops, sets or bellows units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction whether or not indicated on the drawings. Where necessary, bends shall be incorporated in connections to equipment and in branch connections to mains. Cold draw shall be applied to expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe and be flanged at each end. Expansion bellows shall have screwed or flanged ends.

Pipework supports shall allow free axial and/or lateral movement to suit the expansion system employed, except where anchor or guide brackets are installed.



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Pipe anchors shall be constructed to withstand the maximum forces exerted during thermal expansion and contraction and during pressure testing. Guide brackets shall be rigidly secured and provide free movement for axial expansion without undue lateral tolerances.

Visible pipework shall be supported in accordance with BS 1494 on black malleable iron brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the build-in type having properly formed shanks. For thinner walls or partitions, screw-fixing brackets shall be used, secured with black steel screws by means of expanding plugs, fibre or metal plugs, or purpose designed fixing devices where appropriate. Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards.

Pipework in other locations shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel shall be accurately drilled to the correct size.

In certain instances a small pipe may be suspended from a larger pipe; the reverse will not be allowed.

Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
15	1.8	2.5
20 & 25	2.5	3.0
32	2.8	3.0
40 & 50	3.0	3.7
65 & 80	3.7	4.5
100	4.0	4.5
125 & 150	4.5	5.5
200	5.0	6.0
250 & 300	6.0	7.0

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

For supports where pipework is insulated see Clause Pipework & Ductwork Supports, Part C - 'Thermal and Acoustic Insulation'.

At pipe support locations load bearing insulation shall be provided and the pipe support shall be adjusted in size to pass the insulation.



Steam connections shall be taken from the top of common pipework, condensate connections shall be from the bottom to assist in the removal of condensate from the steam main and provide the driest available steam.

C4.3 NON-FERROUS PIPEWORK AND FITTINGS

All pipework installations other than steam pipework i.e., condensate, boiler feed, blowdown, safety valve discharge, drains, and the like shall be of non-ferrous materials.

Pipes shall be of copper complying with BS EN 12449 and shall bear the British Standard Institution's Certification 'Kitemark', manufacturer's name and BS number.

Pipes of nominal sizes up to and including 54mm shall be assembled using either pre-soldered capillary fittings, or heat free pressure jointed fittings. All fittings shall be suitable for the pressure and temperature of the system into which they are being installed, and be assembled and fitted strictly in accordance with the manufacturers instructions.

Heat free pressure jointed fittings shall be manufactured from copper, brass and gunmetal and contain suitable sealing rings.

Pipework up to and including 54mm shall be assembled using high duty capillary fittings to BS EN 1254 with integral rings of silver brazing alloy to BS 1845, Type 3. Pipework 76mm and above shall be assembled by silver brazing using socket and spigot fittings of gunmetal or high quality brazing metal alloy.

Silver brazing shall be carried out in accordance with BS EN 14324 and Technical Note TN4 issued by the Copper Development Association. Care shall be taken to avoid overheating and consequent softening of the copper tube close to the joints. Filler metal shall be a zinc free alloy to BS 1845, Group CP1, and the flux shall be as recommended by the filler metal manufacturer. Flux shall be carefully applied to avoid contamination of the pipe bore. On completion, all excess flux and filler metal shall be removed.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and where necessary, in the pipework system, to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible on completion of the Contract.

Maintenance joints in pipework up to and including 28mm nominal size shall be copper alloy union couplings. Otherwise flanged maintenance joints shall be used throughout. Flanges used for maintenance joints shall be copper alloy, slip-on boss type suitable for silver brazing, complying with BS 4504. Flanges used for connections to flanged equipment shall match the flanges provided on the equipment. All flanged joints shall be made with corrugated brass joint rings coated on both sides with jointing compound all to BS 6956 or BS EN 751-1 as appropriate. Bolts, nuts and washers shall be brass complying with the requirements of the same British Standard and pressure rating as the flanges being connected.

Changes in direction shall be effected by the use of long radius bend fittings or by bends formed from pipe. Elbow fittings shall not be used. Pipe bends shall have a centre line radius not less than three times the nominal pipe size and shall be formed to the requirements of BS 1306.

Branch connections shall be made using tee fittings or factory made tees fabricated from pipe. Tees shall be of sweep form and be taken from the top of condensate mains.



Reduction in pipe size shall be effected using eccentric reducing fittings or formed eccentric taper pieces.

All pipes, manufactured bends and fittings shall be sealed at Works and the sealing left intact until immediately before erection. On removal of the seals, all parts shall be checked for internal cleanliness. During erection open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and reamed to remove burrs. Six union or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory, the six joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between the surface of a pipe or its insulation and finished building surfaces or other pipes or insulation shall be 25mm except for pipes exposed in rooms where 100mm minimum clearance shall be maintained between the pipe surface and the finished surface of the floor.

Pipework shall be fitted at a gradient not less than 1 in 250 in the direction of flow.

Thermal expansion of pipework shall be absorbed by expansion loops, sets or bellows unit. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction, whether or not indicated on the drawings. Where necessary, bends shall be incorporated in connections to equipment and in branch connections to mains to allow for expansion. Cold draw shall be applied to all expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe and be flanged at each end. Loops and formed bends which are subject to expansion movement shall be fully annealed after manufacture. Expansion bellows shall have screwed or flanged ends.

Pipework supports shall allow free axial and/or lateral movement to suit the expansion system employed, except where anchor or guide brackets are installed. Pipe anchors shall be constructed to withstand the maximum forces exerted during thermal expansion and contraction and during pressure testing. Guide brackets shall be rigidly secured and provide free movement for axial expansion without undue lateral tolerances.

Visible pipework shall be supported on gunmetal brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the build-in type having properly formed shanks. For thinner walls, screw-fixing brackets shall be used, secured with brass screws by means of expanding plugs, fibre or metal plugs, or purpose designed fixing devices where appropriate. Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards.

Pipework in other locations shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comments before manufacture and installation.

Holes required in mild steel angle or channel shall be accurately drilled to the correct size.

In certain instances a small pipe may be suspended from a larger pipe; the reverse will not be allowed.



Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
15	1.2	1.8
22 & 28	1.7	2.4
35 & 43	2.0	1.8
54	2.0	3.0
76 & 108	2.4	3.0
133	3.0	3.6
159	3.7	3.6

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

For supports where pipework is insulated see Clause 'Pipework and Ductwork Supports' in the 'Thermal and Acoustic Insulation' Section.

C4.4 COLD DRAW POSITIONS

Cold draw positions shall be included on all steam and condense mains installed between anchor points, whether expansion devices are fitted or not.

During installation, spacer pieces of length equal to the amount of cold draw, shall be included in the pipework. Upon completion of the pipework installation the spacer pieces shall be removed and the pipework drawn together.

C4.5 EXPANSION JOINTS

All expansion joints shall be supplied and installed in accordance with the manufacturers instructions and be complete with all necessary guides, anchors and hangers.

Axial movement shall be compensated for by the installation of expansion bellows. Expansion bellows shall be manufactured from stainless steel with stainless steel inner sleeves and outer protective sleeves.

Lateral movement or vibration shall be compensated for by the installation of braided lateral movement or anti-vibration joints. Lateral movements or anti-vibration joints shall be manufactured from stainless steel bellows with stainless steel braiding.

Where expansion joints are installed in areas where the temperature is higher than normal ambient temperature, precautions shall be taken when setting expansion bellows to allow for contraction when the system is filled.



In order to reduce the forces in the pipework when heated each expansion joint shall be sprung open when being fixed cold (cold drawn) by an amount equal to 40% of the total of each joint, care being taken to see flanges do not 'cup'.

All expansion, lateral movement and anti-vibration joints, shall have flanged ends to BS 4504 or BS EN 1092 as appropriate, as applicable.

C4.6 ANTI-VIBRATION PIPE SUPPORTS

In plant rooms pipework shall be supported from a bracket arrangement incorporating a suitable spring vibration isolator.

C4.7 VALVES

Valves shall be installed in the pipework system and in the steam and condensate connections to all items of equipment.

Valves shall comply with the following British Standard Specifications for the temperature and pressure of the installation as limited by the requirements of BS 759:-

Description	British Standard	Pressure Rating
Copper Alloy Wedge, Double Disc and Parallel Slide Gate Valves	BS 5154 Series B	PN25
Copper Alloy Check Valves	BS 5154 Series B	PN25
Copper Alloy Globe Valves	BS 5154 Series B	PN25
Steel Gate (parallel slide) Valves for general purposes	BS EN 1984	PN16
Carbon Steel Plug Valves	BS 5158	PN16
Carbon Steel Ball Valves	BS ISO 7121	PN16

Valves of nominal sizes up to and including 28mm shall have ends screwed to BS 21 Taper Thread. All other valves shall have flanged ends, complying with BS 4504 or BS EN 1092 as appropriate, as applicable.

Valves shall be installed in positions which permit easy access for operation and maintenance but shall not be installed where a leaking gland may drip on electrical equipment. Gate valves shall preferably be installed with stems horizontal. Unions incorporated in or fitted adjacent to screwed valves shall be positioned on the 'system' as opposed to the 'boiler' side of the valve.

Valve ends shall be sealed at Works and the sealing left intact until immediately before installation in the pipeline. Chromium plated valves shall be protected from damage throughout the Contract period and chromium plating shall be completed in accordance with BS EN 12540.



C4.8 STEAM TRAPS

Steam traps shall be assembled with other equipment to form steam trapping sets and shall be installed in the condensate connections from all items of steam condensing equipment and in drains from steam mains.

Steam traps having screwed ends shall have threads complying with BS 21 taper thread. Steam traps having flanged ends shall have flanges complying with BS 4504 or BS EN 1092 as appropriate.

Steam traps shall be installed in positions which permit easy access for maintenance but shall not be installed where maintenance operations may cause water to drip on to electrical equipment.

Steam traps shall be sealed at Works and the sealing left intact until immediately before installation in the pipeline. Chromium plated traps shall be protected from damage throughout the Contract period and chromium plating shall be completed in accordance with BS EN 12540.

C4.9 SEPARATORS

Separators shall have bodies constructed either SG Iron or Cast Iron.

Separators having screwed ends shall have threads complying with BS 21 taper thread. Separators having flanged ends shall have flanges complying with BS 4504 or BS EN 1092 as appropriate.

Separators shall be installed with a drain connection complete with a dirt pocket and steam trap set, having pipework of size to suit the separator manufacturers recommendations.

Separators shall be sealed at works and the sealing left in-tact until immediately before installation in the pipeline.

C4.10 STRAINERS

Strainers shall be installed in the horizontal plan on all steam connections to all equipment upstream of all automatic control or measuring devices (e.g., automatic control valves, pressure reducing sets, steam meters) and in all steam trapping sets (either as a separate unit or part of the steam trap unit).

Each strainer shall be installed in conjunction with local isolating valves, to enable the screen to be removed without cutting off the supply to equipment served by other branches.

Strainers having screwed ends shall have threads complying with BS 21 taper thread. Strainers having flanged ends shall have flanges complying with BS 4504 or BS EN 1092 as appropriate.

Strainers shall be installed in positions which permit easy access for cleaning-out but shall not be installed where cleaning-out may cause water to drip on to electrical equipment.



Strainers shall be sealed at works and the sealing left intact until immediately before installation in the pipeline. Chromium plated strainers shall be protected from damage throughout the Contract period and chromium plating shall be completed in accordance with BS EN 12540.

C4.11 SIGHT GLASSES

Sight glasses shall be installed in all steam trapping sets.

Sight glasses of nominal sizes up to and including 28mm shall have ends screwed to BS 21 taper thread: all other sight glasses shall have flanged ends to BS 4504 or BS EN 1092 as appropriate.

Sight glasses shall be installed in positions which permit easy access for observation.

Sight glasses shall be sealed at Works and the sealing left intact until immediately before installation in the pipeline. Chromium plated sight glasses shall be protected from damage throughout the Contract period and chromium plating shall be completed in accordance with BS 1224.

C4.12 AIR ELIMINATORS

Air eliminators shall be suitable for the operating temperature of the particular system in which they are installed and be mounted on air bottles installed at all high points in the pipework system.

Automatic air eliminators shall be of the thermostatic type, having copper alloy bodies and stainless steel or non-ferrous alloy working parts, complete with 15mm nominal size inlet connections screwed to BS 21 taper thread, and be complete with separate lockshield valve and strainer on inlet. Air release pipes shall be run from the outlet connections to discharge in an external position. Air release pipework shall be of 15mm nominal size copper tube to BS EN 12449, engraved with manufacturer's name and BS number and assembled with capillary fittings to BS EN 1254, with integral rings of silver brazing alloy to BS 1845 : Type 3. Automatic air eliminators shall be installed in positions which permit easy access for maintenance.

Automatic air vents shall be sealed at Works and the sealing left intact until immediately before installation in the pipework.

C4.13 DRAINS

Steam mains shall be drained at regular intervals at all low points and immediately before connections to pressure reducing sets and steam line drains shall comprise full bore dirt pockets and steam trapping sets as specified in Clause headed 'Steam Traps'.

Condensate and other water pipework shall be fitted with drain cocks at all low points.

C4.14 DIRT POCKETS

Dirt pockets shall be installed in steam mains at all drain points and in the condensate connections from all items of equipment and be of similar material to the pipework in which they are installed.



Dirt pockets in steam mains shall be as shown on Standard Detail 13 of the same nominal size as the steam main and of 300mm minimum length. All dirt pockets shall terminate with a blank flange, complying with BS 4504 or BS EN 1092 as appropriate. Dirt pockets shall comply in all respects with Clause headed 'Steel Pipework and Fittings'.

Dirt pockets fitted in the condensate connections from equipment shall be generally as shown in Standard Details 12, 13 and 15, being of copper or copper alloy of the same nominal size as the condensate connection and having a minimum length of 2 x nominal pipe size. All non-ferrous pockets shall terminate with a blank flange in accordance with BS 4504 or BS EN 1092 as appropriate. Non-ferrous dirt pockets shall comply in all respects with Clause headed 'Non-ferrous Pipework and Fittings'.

Dirt pockets shall be installed in positions which permit easy access for cleaning-out but shall not be installed where cleaning-out may cause water to drip on to electrical equipment.

C4.15 STEAM PRESSURE REDUCING VALVES

Steam pressure reducing valves shall be assembled with other equipment to form steam pressure reducing sets.

Steam pressure reducing sets shall be assembled in accordance with Standard Detail 12.

Steam pressure reducing valves having screwed ends shall have threads to BS 21 taper thread: reducing valves having flanged ends, shall have flanges complying with BS 4504 or BS EN 1092 as appropriate.

Each steam pressure reducing valve shall be capable of maintaining a steady outlet pressure at varying steam flow rates, by utilising a balanced pressure line connected to the discharge side of each valve, and be locked to prevent unauthorised adjustment. The balance pressure pipework shall be in material as specified under the 'Pipework and Fittings' clause of this section of the specification, and be complete with an isolating valve.

Steam pressure reducing valves shall be installed in positions which permit easy access for maintenance but shall not be installed where maintenance operations may cause water to drip on to electrical equipment.

Steam pressure reducing valves shall be sealed at Works and the sealing left intact until immediately before installation in the pipeline.

C4.16 SAFETY VALVES

Safety valves shall be constructed to the requirements of BS 759.

Safety valves having screwed ends shall have taper threads to BS 21. Valves having flanged ends shall have flanges to BS 4504 or BS EN 1092 or appropriate.

Each safety valve shall be capable of discharging saturated steam with an over pressure not exceeding the appropriate value for the type classification given in BS 759. Each valve shall be locked to prevent unauthorised adjustment.



Safety Valves shall be installed in positions which permit easy access for maintenance but shall not be installed when maintenance operations may cause water to drip on to electrical equipment. Discharge pipework in copper in accordance with the clause 'Non-ferrous pipework and fittings' in this section of the specification shall be run from the outlet connection on each safety valve to atmosphere. Drain pipework of 15mm nominal size shall be connected to the lowest point in each discharge pipe and run to discharge to the nearest gully.

Safety valves shall be sealed at Works and sealing left intact until immediately before installation in the pipeline.

C4.17 THERMOMETERS

All thermometers shall be mercury in steel direct-mounting type, complying with BS 5235, having straight, rigid, bottom entry stems and 150mm diameter dials scaled 0-250°C.

Each thermometer shall be screwed into a thermometer pocket, which shall be of the dimensions specified in BS 2765. Mild steel pockets shall be used in steel pipework and copper pockets shall be used in non-ferrous pipework. Mild steel pockets shall be installed by welding and copper pockets by silver brazing. Each pocket shall be installed in the pipework at a suitable angle to enable the thermometer to be easily read from floor level, and in such a manner as to provide adequate circulation over the full pocket length. Where necessary, tees or cross pieces of minimum 65mm nominal size shall be installed to accommodate the pockets. The entrance to each pocket shall be positioned clear of pipe insulation. The gap between thermometer bulb and pocket shall be filled with suitable oil or grease.

C4.18 PRESSURE GAUGES

All pressure gauges shall be direct mounting, bottom inlet Bourdon Tube type, complying with BS 1780 and BS 5235 and having 150mm diameter dials, dials, scaled in kPa to between 1.5 and 2.0 times the system working pressure. Each pressure gauge shall be provided with an adjustable red pointer set to indicate the normal system working pressure. Pressure gauges shall have casings and dials of the same style and finish as the thermometers.

Each gauge connection shall comprise a short branch from the main incorporating a brass syphon and gauge cock. The connection shall be installed with the syphon and gauge cock clear of pipe insulation and in such a manner that the pressure gauge can be easily read from floor level. Gauge cocks shall be of copper alloy with lever handles and ends screwed to suit the connection on the pressure gauges.

Pressure gauges shall have casings and dials of the same style as thermometers.

C4.19 EXHAUST HEADS

Exhaust heads shall be fitted as terminals to all pipes exhausting to atmosphere and in accordance with the typical details included in Part 'D'.



Each exhaust head shall be mild steel galvanised after manufacture and shall incorporate internal baffles to remove condensate from the steam. Galvanising shall be completed in accordance with BS EN ISO 1461. Collected condensate shall be discharged through a copper drainpipe, as described under the clause 'Non-ferrous pipework and fittings', run to terminate in the nearest tundish or gully.

Exhaust heads shall have flanged inlet connections of the same nominal size as the pipes to which they are connected. Flanges shall be to BS 4504 or BS EN 1092 as appropriate.

The steam discharge pipework connecting to each exhaust hood shall be drained at any point which may collect condensate, by 15mm drain pipework, in copper, in accordance with the Clause "Non-Ferrous Pipework and Fittings" in this section of the specification, connected to the lowest point in each discharge pipe run, and taken to discharge to the nearest gully.

C4.20 CONNECTIONS TO EQUIPMENT

Each piece of equipment shall be complete with the following items.

Steam Side

- One - Stop Valves
- One - Strainer, prior to automatic valve where this is installed.

Condense Side

- One - Dirt pocket
- One - Strainer
- One - Steam Trap
- One - Sight Glass

- One - Non-return valve
- One - Gate Valve
- Two - Bronze unions with conical ground seats when items have screwed ends.
Bronze Hexagon nipples for connecting up above items when items have screwed ends.

A by-pass shall be provided around the steam trap set arrangements, complete with the following items:-

- One - Steam Stop Valve after equipment.
- One - Steam Stop Valve in by-pass line.

C4.21 CONDENSE PUMPING UNIT

Condensate pipework shall be installed to allow gravity to assist the removal of the condensate, the pipework falls shall be in the direction of the flow of the condensate.

Condense pumping units shall consist of duplicate pumps, receiver and interconnecting pipework.



Each pump shall be in accordance with the manufacturer's standard construction and capable of pumping at a maximum temperature of 98°C. Pumps having screwed connections shall have threads to BS 21 taper threads. Pumps having flanged ends shall have flanges to BS 4504 or BS EN 1092 as appropriate.

Pressure gauges shall be installed on the suction and discharge connections of each pump.

Pumps with water lubricated glands shall be complete with a 15mm drain pipe connected into a common 22mm drain pipe discharging into the nearest drain gully. The drain pipework shall be in copper to BS EN 1057 R250 and jointed with compression fittings to BS EN 1254.

Each pump shall be complete with an electric motor in accordance with the Electrical Section of this specification.

The motor of each pump shall be controlled by a direct-on-line starter fitted with no-volt and overload release and in accordance with the Electrical Section of this specification.

The pumps shall be provided with anti-vibration mountings.

The receiver cylinder shall be of copper construction fitted with a bolted manhole cover and complete with automatic level float switch, isolating valves on inlet and outlet connections, lead lined cast iron cradles, gunmetal drain cock with loose lever and hose union connection. The receiver cylinder shall have connections up to and including 35mm screwed to BS 21 taper thread and 42mm and over, flanged to BS 4504 or BS EN 1092 as appropriate.

The inter-connecting pipework between the pump and the receiver shall be in copper in accordance with the clause 'Non-Ferrous Pipework and Fittings' in this section of the specification.

Pump discharge pipework, in copper in accordance with the clause "Non-Ferrous Pipework and Fittings" in this Section of the Specification shall be run from each pump, terminating in the position indicated on the drawings. The pipework discharge connection from each pump shall be complete with a line size double regulating valve, as specified in the Clause "Valves" in this Section of the Specification.

An open vent shall be installed from the receiver to discharge in an external position and terminating with an exhaust head. The pipework shall be in copper in accordance with the clause 'Non-ferrous pipework and fittings' in this section of the specification.

An overflow connection shall be taken from each condensate receiver tank, and run to discharge over the nearest open gully. The pipework shall be copper in accordance with the Clause "Non-Ferrous Pipework and Fittings" in this Section of the Specification.

C4.22 HIGH LEVEL RADIANT HEATING STRIP

The strip heating shall be fitted with an aluminium heating surface, sprayed matt black and mechanically attached to the steel heating tubes. The steel tubes shall be 32mm nominal bore to BS EN 10255 with a choice of either medium or heavyweight gauge. The ends of the tube shall be plain for welding.

The aluminium heating surface shall be securely clamped to the top face of the tube to form the radiating face and aluminium foil contained within a galvanised steel backing sheet shall be supplied to insulate the back face.



Each 6 metre length shall be supplied with two support channels. These channels support from beneath the tube and shall be easily moved along the length; they shall be supplied fully assembled at 3 metre support centres in accordance with Table B.16.3 Piping Data of the CIBSE Guide.

C4.23 AUTOMATIC CONTROLS

Automatic control valves, thermostats and loose equipment, shall be fixed as specified in the 'Automatic Controls' Section of the specification. All thermostats and valves shall be positioned to ensure that any leaks from unions, flanged joints and valve glands do not affect the controls.

C4.24 UNIT HEATERS

Each heater shall be fitted with steel headers of copper or with solid drawn copper tubes fitted with copper or aluminium fins expanded over the tubes having pipe connections flanged to BS 4504 or BS EN 1092 as appropriate, drain cocks and isolating valves shall be fitted to all heaters.

Suspension eye bolts shall be fitted to the heater with internal bracing to provide adequate support without strain or distortion on the casing. Suspension type heavy steel brackets shall be supplied and fixed to the steel structure and walls with the eye bolts positioned to suit the location of suspension brackets.

Each heater shall be fitted with extended casings to totally enclose the fan and motor. Those heaters which are fitted with fresh air inlets shall be provided with extended inlets fitted with steel angle flanges to facilitate connection of the ductwork. Heaters without fresh air inlets shall be fitted with heavy wire guards with quick release fastenings.

Casings on all units shall be constructed to permit unrestricted access to the batteries for cleaning and maintenance.

Adjustable curved louvres shall be fitted to the heaters. Motors shall be totally enclosed, continuously rated, suitable for operation with the water temperature stated and wound for the electric supply available. Lubrication nipples shall be extended through the casing tops to approved positions. Starters shall be provided with the equipment. Fans shall be rated to deliver the air volumes against the resistance of the ducting system.

Louvres shall be adjusted to give the correct distribution during testing and regulating.

Test Certificates shall be provided for the heaters confirming pressure tests and thermal output ratings and air volumes.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.

Each heater shall be fitted with an individual number and label.

C4.25 CONVECTORS (NATURAL)

Air venting of each convector element shall be performed through airlet plugs fitted at the manufacturer's works so that air venting may be performed without having to remove the inspection panel. Air vent plugs must not protrude clear of the heater cabinets.



Each convector shall have top and bottom grilles with damper control fitted to each top grille and be of the floor or wall mounting pattern.

Each convector shall be provided with the manufacturer's standard sheet steel liner constructed to fit neatly around the element to form an air duct and obtain maximum stack effect to guide the cooler air through the element and direct the warmed air forward through the discharge top grille. Each liner shall be provided with adjustable element support brackets to allow adjustment for grading the element to vent through the airlet plug.

Each heater casing and front plate shall be completely de-rusted prior to the dispatch from the manufacturer's works, and after de-rusting shall be coated with a suitable primer. Where necessary, further treatment and priming shall be carried out on site to prepare the surfaces for decorative painting.

Each convector casing shall be securely supported to the building structure in a suitable manner and shall incorporate insulation material between the rear casing and building structure where specified.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.

C4.26 MECHANICAL CONVECTOR HEATERS

The duties shall be calculated in accordance with BS EN 442. Each heater casing shall be supplied with all necessary inspection panels, inlet and outlet grilles with suitable seals and fixing screws.

Each heater shall have a sinuous coil non-ferrous finned tube heating element with screwed connections, super-silent flexibly mounted electric motor directly driving centrifugal casing fan runners, and a washable type filter.

Air venting of the heater batteries shall be arranged through airlet tappings provided on the heating elements, complete with copper pipes and air cocks so that they can be operated from outside the casing without having to remove inspection panels.

Remote convectors with ductwork shall have the grilles and spigots fixed to suitable timber frames.

Electric switches shall not be incorporated in the convectors unless otherwise specified.

Heaters shall be supplied complete with built-in thermostats or shall be supplied with loose thermostats for remote fixing. Each heater shall be complete with all internal electric wiring between the terminal block and motor, and where provided, built-in thermostats.

Each heater casing and its access panels shall be completely de-rusted prior to the dispatch from the manufacturer's works, and after de-rusting shall be coated with a suitable primer.

Where necessary, further treatment and priming shall be carried out on site to prepare the surfaces for decorative painting.

On completion of the Contract and prior to handover, each cover shall be removed, the element and casing thoroughly cleaned and the cover replaced.



C4.27 FLUSHING & CLEANING OF PIPEWORK SYSTEMS

Each system shall be flushed and cleaned in accordance with the principles laid down in the BSRIA Application Guide 1/2001.1 entitled 'Pre-Commission Cleaning of Pipework Systems'.

All recommended reporting procedures, and progressive recording for the flushing, cleaning, and treatment of each system shall be provided as part of this section of the works. A detailed method statement covering the cleaning and flushing process, including coloured schematic drawings illustrating the dynamic flushing flow paths similar to those detailed in the Application Guide shall be provided to the Services Engineer prior to the commencement of the cleaning process. The method statement shall be discussed with the water treatment specialist prior to Tender and any additional equipment, valves and the like, required to comply with this Application Guide 1/2001.1 shall be provided as part of this section of the works.

Chemical cleaning shall be carried out using a suitable cleaning agent incorporating a polymer/dispersant and an inhibitor. This solution shall be circulated around the system for a minimum of 12 hours.

The selected chemicals shall be capable of controlling all corrosive, aggressive and bacteriological agents contained within the water to be used within the system.

Particular attention shall be given to local water conditions, and this section of the works shall include the responsibility to control all adverse conditions including pseudomonas.

Where required by the Local Water Authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

Following Local Water Authority approval, either neutralise and dispose to drain off all waste products, or ensure authorised disposal at registered site.

After flushing and cleaning the complete installation, comprising all pipework, tanks, cisterns and other equipment connected to the Cold Water Supply System, shall be efficiently sterilised before handover.

Sterilisation shall be carried out by the Specialists to the requirements of BS 6700. The sterilisation Specialists shall be informed of all constituent materials in the system, to ensure that suitable chemicals are selected. On completion, the system shall be thoroughly flushed out to remove all traces of sterilising chemicals.

Clean Steam

Hospital or process steam loads should undergo suitable water treatment to the incoming water supply to generate clean steam, reverse osmosis being a typical method of removing dissolved solids from untreated water supplies, prior to creation of the steam.

Where steam is to be used for sterilisation the use of filming amines for the prevention of condensate corrosion shall be prohibited as this is highly toxic. All hospital steam installations shall comply with HTM2030.



PART C - SECTION 7 HOT WATER SUPPLY

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PART C - SECTION 7

HOT WATER SUPPLY

C7.1 GENERAL

Where applicable the installation shall comply with BS 6700, BS EN 752 and BS EN 1610, together with the requirements of the Water Regulations. All equipment and fittings shall be suitable for use on potable supplies and shall be Water Regulations Advisory Scheme (WRAS) approved.

In addition, the installation shall be compliant with the recommendations set out within the HSE Approved Code of Practice 'The Control of Legionellae Bacteria in Water Systems', together with CIBSE TM13 'Minimising the risk of Legionnaires Disease'.

C7.2 PIPEWORK AND FITTINGS (WITHIN BUILDINGS AND DUCTS)

Pipes shall be of copper to BS EN 1057 R250 (up to and including 159mm), BS EN 12449 (over 159mm) and shall bear the British Standards Institution's Certification "Kitemark", the manufacturer's name and BS/EN number.

Pipes of nominal sizes up to and including 54mm shall be assembled using either pre-soldered capillary fittings, heat free pressure jointed fittings, or push fit fittings. All fittings shall be suitable for the pressure and temperature of the system into which they are being installed, and be assembled and fitted strictly in accordance with the manufacturers instructions.

Pre-soldered capillary fittings shall be lead free copper or copper alloy, tin/copper complying with BS EN 1254. Capillary joints made in chromium plated pipe shall have the plating removed from the length engaged in the fitting socket. On completion, all excess flux and solder shall be removed and chromium plated pipes and fittings shall be washed with soap and warm water to remove heat discolouration.

Heat free pressure jointed fittings shall be manufactured from copper, brass and gunmetal and contain suitable sealing rings.

Push fit fittings shall be manufactured from copper brass and gunmetal, and contain suitable tube stops, sealing rings, release collars, and stainless steel grab rings.

Push fit fittings shall only be used for the final jointing to equipment, and in readily accessible areas. Push fit fittings shall not be installed in concealed locations.

Pipes of nominal sizes larger than 54mm shall be assembled by brazing, using cast high quality lead free brazing metal alloy fittings.

Pipes and fittings shall be supplied with plain finish, except where chromium plated finish is required. Chromium plating shall comply with BS EN 12540.

Changes in direction shall be accomplished using bends with a centre line radius/nominal bore of not less than 1.5 dia. For reductions and enlargements use easy transition type with included angle not exceeding 30°, reducing sockets shall be of the eccentric type.



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Tees shall be of the swept pattern, except for connections to drains, vents and cold feeds where square tees shall be used.

Bushes shall not be used.

Any screwed joints to valves, gauges, and the like shall be to BS 21 using PTFE tape to BS 7786.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and, where necessary, in the pipework system, to allow for easy erection and dismantling of the installation.

Maintenance joints shall be positioned where they will be accessible on completion of the Contract.

Maintenance joints in pipework up to and including 54mm nominal size shall be copper alloy union couplings, bronze to bronze navy pattern. Flanged maintenance joints shall be used in pipework of nominal sizes greater than 54mm. Flanges shall be solid full face copper alloy, slip-on type suitable for brazing, complying with BS 4504 : PN10 or BS EN 1092 as appropriate. Flanges used for connections to flanged equipment valves, and the like shall match flanges provided on the equipment. All flanged joints shall be made with full face rubber insertion jointing rings to BS 7874 or BS EN 681 and BS EN 682 as appropriate, brass nuts, bolts and washers, complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure except where specified or indicated on the drawings.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Pipes shall be thoroughly cleaned before erection. Six union or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory the six joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between any service and a service or building element shall be as follows, after allowing for thickness of any insulation:

<u>Between</u>	<u>And</u>	<u>Clearance</u>
Uninsulated or insulated pipework:	Wall, ceiling or soffit: :	100mm
	floor :	150mm
Insulated pipework:	Adjacent service (insulated) :	25mm
Insulated pipework:	Adjacent service (uninsulated) :	75mm
Uninsulated pipework	Adjacent service (uninsulated) :	150mm

During erection, open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Except where exposed in rooms, pipework shall be fitted at a gradient not less than 1 in 250.

Visible pipework shall be supported on gun-metal brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the build-in type having properly formed shanks.



For thinner walls, screw-fixing brackets shall be used, secured with brass screws by means of expanding plugs fibre or metal plugs, or purpose designed fixing devices where appropriate. Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards. Chromium plated brackets, screws, and the like shall be used for supporting chromium plated pipework.

Pipework in other locations shall be installed in accordance with the typical details included elsewhere in this specification and generally in accordance with BS 3974. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel members shall be accurately drilled to the correct size.

In certain instances, a small pipe may be suspended from a larger pipe, the reverse will not be allowed.

Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
15	1.2	1.8
22 & 28	1.7	2.4
35 & 43	2.0	3.0
54	2.0	3.0
76 & 108	2.4	3.6
133	3.0	3.6
159	3.7	3.6

Thermal expansion of pipework shall be absorbed by expansion loops, sets, or bellows units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction whether or not indicated on the drawings.

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

Dead leg branches from the circulation system serving non blended outlets shall not exceed 5m.

For blended outlets, dead leg branches from the circulation system to the blenders shall not exceed 1.5m.

For supports where pipework is insulated see Clause 'Pipework & Ductwork Supports' in the 'Thermal and Acoustic Insulation' Section.



In order to prevent stress fractures occurring in valves and fittings, all materials and components used on the hot water supply shall be confirmed by the manufacturer to be suitable and compatible with the operating temperatures, fluids, and other components of the system. Brass fittings and components should not be used. Acceptable materials would include Copper Alloy, DZR Alloy and Gunmetal.

C7.3 VICTAULIC TYPE FITTINGS (Copper Pipework Systems)

Where specified, copper pipework shall be assembled using specialist fittings for the pipe e.g., Victaulic Coparite fittings. Changes in direction shall be accomplished by using either long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter or Victaulic short radius elbows. For reductions and enlargements easy transition type with included angle not exceeding 30° shall be used. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.

All Victaulic Coparite fittings shall be zinc plated, gold chromate colour.

Earth continuity shall be provided via the couplings. The maximum working pressure shall be 10 bar.

Final connections to air conditioning terminal units (fan coils, VAV units and the like) plus all other pipes and fittings (cold feeds, open vents, drains, overflows and the like) shall be either Victaulic Coparite or copper, to the requirements of BS EN 1057 R250, assembled with tin/copper pre-soldered capillary type fittings to BS 864 : Part 2, using bends and square tees.

When the thermal expansion cannot be incorporated within the working limits of the Victaulic joint, then the thermal expansion of pipework shall be absorbed by expansion loops, sets or bellow units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction, whether or not indicated on the drawings.

Where necessary, bends shall be incorporated in connections to equipment and in branch connections in mains. Cold draw shall be applied to all expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe. Expansion loops and bellows up to and including 50mm, shall have welded or grooved ends. All other expansion loops or bellows shall have flanged or Victaulic grooved ends.

C7.4 EXPANSION JOINTS

All expansion joints shall be supplied and installed in accordance with the manufacturers' instructions and be complete with all necessary guides, anchors and hangers.

Axial movement shall be compensated for by the installation of expansion bellows. Expansion bellows shall have union joints up to and including 50mm and flanged above.

Expansion bellows shall be manufactured from stainless steel with stainless steel inner sleeve and outer protection sleeve.



Lateral movement or vibration shall be compensated for by the installation of braided lateral or anti-vibration joints. These shall have union joints up to and including 50mm and flanged joints above. Lateral movement or anti-vibration joints shall be manufactured from stainless steel bellows with stainless steel braiding.

Where expansion joints are installed in areas where the temperature is higher than normal ambient temperature, precautions shall be taken when setting expansion bellows to allow for contraction when the system is filled.

In order to reduce the forces in the pipework when heated each expansion joint shall be sprung open when being fixed cold (cold drawn) by an amount equal to 40% of the total of each joint, care being taken to see flanges do not 'cup'.

C7.5 ANTI-VIBRATION PIPE SUPPORTS

In plant rooms, where there is a potential for vibration transmissions via the installation, pipework shall be supported from a bracket arrangement incorporating a suitable spring vibration isolator.

C7.6 VALVES

Valves shall comply with the following British Standard Specification for the temperature and pressure of the installation:-

Description	British Standard
Ball Valves (Float Operated, up to and including 25mm)	BS 1212
Copper Alloy Stop Valves (Loose Jumper)	BS 1010 PT.2
Copper Alloy Wedge and Double Disc Gate Valves	BS 5154 Series B
Copper Alloy Check Valves	BS 5154 Series B
Butterfly Valves	BS EN 593
Diaphragm Valves	BS EN 13397

Valves of nominal sizes, 54mm and less shall have ends screwed to BS 21 taper thread or shall have capillary ends to BS EN 1254. Larger valves shall have flanged ends, complying to BS 4504 or BS EN 1092 as appropriate and be similar to these selected for the pipework.

Cast iron valves shall not be utilised on hot water supply systems.

Copper Alloy Stop Valves shall be provided with Capstan heads marked 'H'. All other valves shall be provided with wheel handles.



Valves shall be installed in positions which permit easy access for operation and maintenance but shall not be installed where a leaking gland may drip on electrical equipment. Gate valves shall preferably be installed with stems horizontal. Unions incorporated in, or fitted adjacent to valves with screwed or capillary ends, shall be positioned on the "draw-off" side of the valve.

Valves installed in all branch pipework shall be fitted as close to the main as practicable in order to reduce the length of the upstream "dead leg" to an absolute minimum.

Valve ends shall be sealed at works and the sealing left intact until immediately before installation in the pipeline. Chromium-plated valves shall be protected from damage throughout the Contract period, and chromium plating shall comply with BS EN 12540.

Flow and pressure measurement valves shall be located to ensure manufacturer's recommended straight length of pipe upstream and downstream of valves is provided.

C7.7 DRAIN COCKS

Drain cocks shall be installed on all items of equipment and all low points in the pipeline system and adjacent (within 250mm) to valves isolating sub-circuits to enable the whole, or sections of the system, to be drained down.

Drain cocks installed in the pipework system shall be of 15mm nominal size. Drain cocks at the foot of risers and in Plant Rooms shall be 25mm nominal size. The sizes of other drain cocks are specified with the equipment concerned.

Drain cocks shall be copper alloy of the screwdown pattern to BS 2879. Each drain cock shall have inlet end screwed to BS 21 taper thread, ribbed outlet end suitable for hose attachment and lockshield type head. Three lockshield keys shall be provided for each size of drain cock installed.

Drain cocks shall be fitted clear of pipe insulation and in positions allowing easy operation.

C7.8 DEAERATOR

A line size deaerator shall be installed in the main flow pipe from the hot water generator.

Isolating valves shall be installed to allow the deaerator to be easily and readily removed from the installation.

The deaerator shall be manufactured from brass which will not be subject to dezincification, and units of nominal sizes 35mm and below shall have ends tapped to BS21, whilst units 43mm and above shall have ends flanged to BS 4504.

C7.9 AIR ELIMINATORS

Air eliminators shall be suitable for the operating temperature of the particular system in which they are installed and be mounted on air bottles installed at all high points in the pipework system.



Manually operated eliminators shall be 8mm nominal size nickel plated copper alloy, spoutless, lockshield type air cocks with inlet ends screwed to BS 21 taper thread. Air cocks shall be fitted in easily accessible positions, extension pipes being provided where necessary between the connections on the mains and the air cocks. Extension pipework shall be of 8mm nominal size copper tube to BS EN 1057 R220, assembled with capillary fittings to BS EN 1254. In all cases, air cocks shall be arranged to discharge clear of pipe insulation. A total of six air cock keys shall be supplied.

Automatic air eliminators shall be of the float-operated type, having aluminium bronze bodies and stainless steel working parts, 15mm nominal size inlet connections screwed to BS 21 taper thread, and be complete with separate lockshield valve and strainer on inlet. Air release pipes shall be run from the outlet connections to discharge in an external position. Air release pipework shall be of 15mm nominal size copper tube to BS EN 1057 R250, and assembled with capillary fittings to BS EN 1254. Automatic air eliminators shall be installed in positions which permit easy access for maintenance.

Air bottles shall be made from 200mm lengths of 54mm nominal size pipe having inlet connections of 54mm or mains size, whichever is the smaller.

C7.10 THREE WAY ESCAPE VALVES AND COCKS

Three way escape valves and cocks shall be of full bore construction of the same nominal size as the vent pipe in which it is installed and shall be designed to maintain an escape route between the inlet port and either, or both, of the other two ports at all positions of the operating handle.

Escape valves and cocks shall have copper alloy bodies and working parts, and have ends screwed to BS 21 taper thread. Valves shall be provided with wheel handles and have renewable disc. Cocks shall be of the gland pattern and have removable wrench-type handles. A drainpipe shall be run from the drain port of each valve and cock, to terminate 200mm above floor level. Drain pipes shall be of the same nominal size as the vent pipe and be of copper to BS EN 1057 R250, assembled with tin/copper pre-soldered capillary fitting to BS EN 1254 and be adequately supported.

C7.11 TEMPERATURE MEASUREMENT

Provision for temperature measurement in the pipework system shall be made by installing thermometer pockets and thermometers.

Pockets shall be copper alloy screwed to BS 21 and shall be of length and diameter to suit the bulbs of the specified thermometers. Each pocket shall be installed in the pipework at a suitable angle to enable a fitted thermometer to be easily read from floor level, and in such a manner as to provide adequate circulation over the full pocket length. Where necessary, cross pieces of minimum 50mm nominal size shall be installed in the pipework to accommodate the pockets. The entrance to each pocket shall be positioned clear of pipe insulation.

All thermometers shall be mercury in steel direct-mounting type, having a straight rigid bottom entry stem suitable for use with the specified pockets. Dials shall be 100mm diameter calibrated 0-120°C.

Where thermometers are permanently fixed, the gap between thermometer bulk and pocket shall be fitted with suitable oil or grease. Empty pockets shall be fitted with copper alloy screwed plugs.



C7.12 PRESSURE MEASUREMENT

Provision for pressure measurements in the pipework systems shall be made by installing gauge connectors and pressure gauges.

Each gauge connector shall comprise a short branch from the main terminating with a gauge cock. Branches shall be of sufficient length to clear pipe insulation. Gauge cocks shall be of copper alloy with lever handles and ends screwed to BS 21 to suit the connections on the specified pressure gauges. Each connector shall be arranged to allow a fitted gauge to be easily read from the floor level.

All pressure gauges shall be direct mounting bottom inlet Bourdon Tube type, complying with BS 1780 and BS 5235 and having 100mm diameter dials, calibrated in bar to between 1.5 and 2 x the maximum working pressure in the system. Each pressure gauge shall be provided with an adjustable red pointer which, in the case of the permanently mounted gauges, shall be set to indicate the normal working pressure at that point in the system. Where fitted in pressure vessels gauges shall be clearly marked with maximum permissible working head in accordance with BS 759.

Pressure gauges shall have casings and dials of the same style as thermometers.

C7.13 CIRCULATING PUMPS

Where pumps come within the scope of BS 1394 : Part 2, they shall comply with Part 1 : Grade 1, or Part 2 : Grade 1 of that standard, as appropriate to the type, size, pressure and temperature conditions for the pump.

Pumps shall be specifically designed for use in Hot Water Supply Systems, and unless otherwise specified shall be of bronze or gunmetal construction.

Pumps having screwed ends shall be BS 21 taper thread and those with flanged ends shall be to BS 4504 or BS EN 1092 as appropriate and similar to those selected for the pipework installation. Where pump ends are of smaller nominal size than connecting pipework, eccentric reducers shall be installed immediately adjacent the pump and all valves, strainers, and the like shall be of the same size as the main line connecting pipework.

Each pump shall be driven by an electric motor and each motor shall be controlled by a speed controller and automatic starter. See clause headed 'Motor Control Gear' contained within Part 'C' - Electrical.

Each pump and motor shall be correctly aligned and efficiently balanced to minimise vibration. Drive belts where fitted shall be properly tensioned.

Floor mounting pump units shall be mounted on suitable inertia anti-vibration bases and be complete with flexible pipe connections. Pipework connections shall be arranged and supports provided to prevent transmission of pipeline forces into the pump casings.

Pipeline mounting pump units shall be supported by means of brackets fitted in the pipeline adjacent to the suction and discharge connections. Supports within 3.0m of each pump unit shall be lined with 'Tico Clip-Strip' or similar vibration absorption materials.

Pumps which incorporate packed stuffing boxes shall be fitted with drainpipes run from the connections provided to discharge into the nearest gully. Drains from groups of pumps, to BS EN 60335 where applicable, may be collected into a 50mm diameter copper tundish and a common drain run to the discharge point.



Drain pipework shall be of 22mm nominal size copper tube to BS EN 1057 R250 assembled with tin/copper pre-soldered capillary fittings to BS EN 1254. To facilitate cleaning use plugged tees instead of elbows.

Dual pump sets, comprising two pumps fitted in parallel as a package unit, shall have screwed or flanged ends, as specified for individual pumps, to BS EN 60335 where applicable, and each set shall incorporate an automatic flap valve to prevent re-circulation through the stationary pump. Each dual pump set shall be supplied with a blanking-off plate and gasket to allow closure of either volute casing when motor and impeller are removed.

Where a duplicate pump set comprises two pumps connected in series, a short piece of pipe of the same nominal size as the pumps shall be supplied. This pipe shall be cut to length, screwed or flanged, to suit and arranged to fit in place of either pump should one be taken out of circuit.

A gauge connector, with fixed pressure gauge, shall be fitted in the suction and discharge connections to each pump, or each pair of duplicate pumps to BS EN 60335 where applicable.

Before handover, bearings shall be maintained in good condition by lubricating to the manufacturer's recommendations and (except for glandless pumps) by rotating pump and motor shafts daily.

Each pump shall be subjected to a hydrostatic test pressure at the manufacturer's works, of not less than 1.5 x the maximum working pressure. A Test Certificate shall be provided for each pump certifying that it has been subjected to the specified hydrostatic pressure, that it performs to the type, test, duty and, where applicable, that it complies in all respects with BS 1394 : Part 2 and BS 5257.

Each pump shall be selected to ensure that the specified duty is not on or close to, or at the top or close to the top of, a particular performance curve.

Each installed pump shall have a body and impeller which is capable of handling an increase in pressure which is a minimum of 15% above the specified total pressure at the design volume.

The motor of each installed pump shall have a size/rating which is a minimum of 15% greater than that required for the selected unit body and impeller.

For belt driven pumps, note should be taken of the Clause headed 'Belt Driven Equipment' contained within Part 'B' of this Specification.

Notice should be taken of the Equipment Selection Clause contained within Part B of this part of this Specification, which requires a margin on all motors at the specified duty.

C7.14 THERMOSTATIC MIXING VALVES

All thermostatic mixing valves shall comply with the requirements of the NHS Estates specification DO8, and unless concealed, have a chromium plated finish to BS 12540. Where of the surface mounting pattern, the exposed connecting pipework, valves, fittings and brackets shall have a finish similar to the valve.

The hot and cold water service connections to each mixing valve shall be complete with the manufacturer's inlet check valve, strainer and a stop cock as specified under the "Valve" clause of this section of the Specification.



All surface mounted thermostatic mixing valves shall be suitably fixed to the wall with chromium plated brass screws.

All thermostatic mixing valves installed on healthcare projects shall be Type 3 and be manufactured and fixed, in accordance with the NHS Estates specification DO8. 'Thermostatic Mixing Valves (Healthcare Premises)'.

C7.15 FLUSHING, CLEANING & STERILISATION OF WATER SYSTEM

Each system shall be flushed and cleaned in accordance with the principles laid down in the BSRIA Application Guide 1/2001.1 entitled 'Pre-Commission Cleaning of Pipework Systems'.

All recommended reporting procedures, and progressive recording for the flushing, cleaning, and treatment of each system shall be provided as part of this section of the works. A detailed method statement covering the cleaning and flushing process, including coloured schematic drawings illustrating the dynamic flushing flow paths similar to those detailed in the Application Guide shall be provided to the Services Engineer prior to the commencement of the cleaning process. The method statement shall be discussed with the water treatment specialist prior to Tender and any additional equipment, valves and the like, required to comply with this Application Guide 1/2001.1 shall be provided as part of this section of the works.

Chemical cleaning shall be carried out using a suitable cleaning agent incorporating a polymer/dispersant and an inhibitor. This solution shall be circulated around the system for a minimum of 12 hours.

The selected chemicals shall be capable of controlling all corrosive, aggressive and bacteriological agents contained within the water to be used within the system.

Particular attention shall be given to local water conditions, and this section of the works shall include the responsibility to control all adverse conditions including pseudomonas.

Where required by the Local Water Authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

Following Local Water Authority approval, either neutralise and dispose to drain off all waste products, or ensure authorised disposal at registered site.

After flushing and cleaning the complete installation, comprising all pipework, tanks, cisterns and other equipment connected to the Cold Water Supply System, shall be efficiently sterilised before handover.

Sterilisation shall be carried out by the Specialists to the requirements of BS 6700. The sterilisation Specialists shall be informed of all constituent materials in the system, to ensure that suitable chemicals are selected. On completion, the system shall be thoroughly flushed out to remove all traces of sterilising chemicals.

C7.16 PRESERVATION OF WATER QUALITY

1. General

In order to preserve the quality of water this section of the works shall :



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provide for all parts of cold water circuits in contact with the water to have clean and disinfected surfaces after being installed.

require all materials specified and used to be proof against the following hazards :-

- (a) dezincification of galvanic action.
- (b) chlorine treatments.
- (c) imparting taste or odour to the water.
- (d) contamination of water by lead, copper or other elements in excess of standards laid down by the EEC, See Clause 6.
- (e) bacterial growth due to nutrients in pipework materials, jointing materials, pastes and compounds, fluxes, solders, thread sealant tapes, gaskets, grommets, tap washers, 'O' rings, gland packings, valve seats, filters, hoses, greases, lubricants, protective coatings or linings.

include for all materials and fittings to be of an approved type as tested and listed by the Water Research Centre, as suitable for potable water and not capable of promoting bacterial growth.

have pipework circuits for cold water run below, or away from, hot pipes to minimise heat gain and keep water temperatures below 20°C to prevent the multiplication of Legionella bacteria.

incorporate backflow prevention devices or air gaps provided as shown on the drawings and specified within this Specification, based on BS 6700 and to BS EN 13076, BS EN 13077 and BS EN 14451 as appropriate.

2. Disinfecting of Cold Water Systems

Disinfection procedures shall :-

- be carried out following satisfactory flushing, pressure testing and setting-to-work prior to handover.
- apply to each system including cisterns, vessels, pipework which shall be disinfected with chlorine by either a Specialist organisation certified to BS EN ISO 9002 for this type of work or the Local Water Undertaking.
- follow DoH – HTM 04-01 "The Control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems", Code of Practice, BS 6700 and as outlined in the following clauses for new installations and for extended or modified systems. Any variations required shall be specified elsewhere.
- for Healthcare Buildings, adopt all recommendations/requirements set out within the relevant Health Technical Memorandums (HTM's).

Note : Flushing is not a substitute for a high degree of cleanliness during installation.

3. External Mains Disinfection

Note : All chlorination of pipework under pressure from the mains must be carried out in accordance with the requirements of the local Water Undertaking.



External mains disinfection shall :-

- be through suitable valved filling points (at one end of the system) for introducing the chlorous solution.
- have chlorine introduced by means of chemical dosing apparatus connected upstream until a concentration of not less than 20 ppm can be measured along the pipe run of new mains.
- have the main left static for not less than 24 hours (alternatively concentration of 50 ppm for one hour may be used) before flushing through with fresh water until chlorine cannot be detected at a level above that in the water undertaking mains.
- have wash-out valves and valved filling points included in the installation.

Existing mains supplying new distribution systems may require re-chlorination.

Any repairs or insertion at junctions into an existing pipeline shall have the new and existing components disinfected by immersion in a solution of sodium hyperchlorite containing 1000 mg/l of free available chlorine.

4. Distribution Pipework Chlorination

Each distribution system shall :-

- have the mains supply to storage cisterns satisfactorily chlorinated as necessary, and all cisterns cleaned of all visible contaminants before services within buildings are treated.
- have all water drained off and all draw-off points closed and all isolating valves opened except on cistern outflow.
- after flushing, be filled with clean water and chlorinated as required under BS 6700 and the HSE's Approved Code of Practice and Guidance L8 for control of Legionella,
- for Healthcare Buildings, after flushing be filled with clean water and chlorinated as detailed in the DoH HTM 04-01. The Control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems".

Except : The concentration of chlorine within the cistern(s) and at all taps and outlets shall be 40 to 50 ppm and not 30 ppm as given in the ACoP.

The above procedures shall be applied to all cold water services and to all the secondary circuits of hot water systems before heat is applied and with the water cold. Care shall be taken not to use excessive amounts of chlorine which may affect pipework or other materials. Records must be kept of all procedures, checks, tests and witnessing.

Note : It is essential that the internal coatings of cisterns are thoroughly cured before disinfection takes place and care must be taken not to exceed 50 ppm chlorine concentration.



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During chlorination, all taps shall have suitably worded notices on their non use for normal purposes.

5. Prevention of Water Stagnation

This shall provide for the flushing of each system with clean water on a routine basis until handover, generally carried out twice weekly unless otherwise specified.

6. Testing of Water Quality

All systems shall have been satisfactorily set-to-work and disinfected before water samples are taken.

Testing shall :-

- include for analysis of each hot and cold water supply system taken from representative sampling points at draw-off and storage positions with the systems at working temperatures.
- Include for all samples to be tested in accordance with Report No.71 - The Bacteriological Examination of Water Supplies, DoH/DoE or any appropriate method approved and employed by the Public Health Analyst.
- have all water samples tested for E.Coli and chemical analysis including a copper and lead content. The quality of potable water at outlets (and as sampled) shall be as supplied by the Water Authority and generally to EC Directive, 15th July 1980, 80/778/EEC "Quality of Water intended for Human Consumption". Potable water from a borehole supply shall comply with DOE Circular 25/84 and EC Directive 80/778/ELEC.
- have samples taken and analysed initially as a reference point as agreed with the Services Engineer or his representative.

Generally samples will be taken from:-

Main supply on site
Storage Cistern (Hot/Cold)
H & C Outlets (to be agreed with Services Engineer) in each Department/Area within the building.

The samples shall be analysed by the Public Health Laboratory Service or the local Water Undertakings as specified.

Include for two sets of tests, the first after setting-to-work and disinfecting and the second in conjunction with the handover date and the date for occupation of the premises.

7. Legionnaires Disease Precautions

Shall :-

- be in accordance with HSE's Approved Code of Practice and Guidance L8 for the 'Control of Legionella Bacteria in Water Systems'.
- for Healthcare Buildings, be in accordance with the requirements of DoH HTM 04-01.



- include for taking water samples for Legionellae bacteria from all hot and cold water systems. The method for obtaining samples shall be to the Public Health Laboratory Services requirements.
- provide for the tests to be carried out by the Public Health Laboratory Services on samples taken from representative sampling points when the systems are at working temperature and conditions.
- include for temperature of the water (hot or cold) at the sampling point to be recorded at the time of taking each sample.
- have water samples, for analysis, taken from three hot and three cold water outlets, the location of the outlets to be determined by the Services Engineer.
- provide for the samples and their analysis to be carried out prior to Practical Completion and the Services Engineer notified of the results.

8. Analysis Reports

Shall :-

be discussed by the Services Engineer with the Medical Officer for Infection Control. Where results are not satisfactory, suitable remedial action shall be agreed upon and undertaken at the pipework installer's expense.

C7.17 OPEN VENT (NATURALLY VENTED SYSTEM)

An open vent shall be taken direct from each calorifier and connected to a common open vent, installed between the calorifier chamber and each cold water storage tank, the end of the pipe being turned down to discharge inside each tank.

The pipework material and fittings shall be as described in the 'Pipework and Fittings' clause of this section of the Specification.

Under no circumstances must any obstruction be placed in any section of the open vent pipework other than the 3-way escape valve.

C7.18 COLD FEED (NATURALLY VENTED SYSTEM)

A common cold feed connection shall be installed from the cold water storage tanks and connected to each calorifier.

A non-return valve shall be installed on the cold feed connection within 300mm of each calorifier. The pipework material and fittings shall be as described in the 'Pipework and Fittings' clause of this section of the Specification.

The outlet from each cold water storage tank and the cold feed inlet to each calorifier shall be provided with an isolating valve, complete with locking device and open and shut indication.



C7.19 WATER DOWNFEED BOOSTER & EXPANSION VESSEL

Water pressure booster sets and expansion vessels shall be provided capable of providing a constant minimum system pressure, whilst handling the specified flow rate, and suitable for use in a domestic hot water installation.

Each unit shall be fully packaged, pre-wired, and mounted on a heavy duty flat steel common base frame, complete with suitable anti-vibration mountings. Each unit shall be fully painted to a high standard gloss finish.

Each unit shall be complete with duty standby pumps of all stainless steel construction, arranged for duty sharing. Each pump shall be capable of handling 100% of the total flow duty, and be complete with suction and delivery valves, non-return, drain and system valves, as specified in the clause headed 'Valves' in this section of the specification.

Each unit shall incorporate a suitably sized replaceable diaphragm pressure accumulator to avoid erratic operation of the pumps to BS EN 60335 where applicable.

Each unit shall be provided with fully wired control panel incorporating mains isolator, pump starters/overloads, over run timers, fuses, pump on to change over, pump run and trip lamps, mains alive lamps, micro processor controlled system, no volt contacts for connection to a BMS system and hand off auto switches. Each high unit shall be complete with low water pressure alarm and cut off switches, and all necessary pressure switches for pump control.

Each unit shall be complete with a domestic hot water type expansion vessel complete with replaceable diaphragm, suitable for handling the system expansion, and supplied with a pressure reducing valve set to reduce the off plant operating pressure to the hot water service system working pressure.

All unit interconnecting pipework and fittings, and the like shall be in copper as specified in the pipework and fittings clause of this section of the specification, and each unit shall be fitted with flexible suction and discharge pipe connections suitable for use with domestic hot water systems.

Each unit shall be pre-set and fully tested and commissioned at the manufacturer's works prior to delivery to site.

Under no circumstances shall any obstruction i.e., isolating valve or NRV be placed in the pipework between the pressurisation unit and the hot water calorifiers/system to which it is connected.

C7.20 STORAGE CALORIFIERS

Storage calorifiers shall conform to BS 853 : Part 1 and all materials shall be resistant to dezincification.

All calorifiers shall have bolted heads and a full faced heat resistant rubber joint between the top flange and the shell flange.



All secondary cold feed, open vent and mounting connections shall be in gunmetal, sizes up to and including 25mm being screwed bosses tapped female to BS 21 and 32mm and above flanged to BS 4504 or BS EN 1092 as appropriate. All connections shall be of such a length so as to project clear of the finished face of the calorifier insulation to facilitate ease of disconnection.

All calorifiers shall be complete with a 3-way escape valve complete with a full bore drain connection of copper to BS EN 1057 R250 and jointed with tin/copper pre-soldered capillary fittings to BS EN 1254 fitted neatly down the side of the calorifier and terminating 200mm above the finished floor level. The copper discharge pipe shall be suitably stayed to prevent movement when installed.

Horizontal calorifiers shall be mounted on lead lined mild steel cradles, painted with two coats of red oxide paint after manufacture. The base of vertical calorifiers shall consist of a supporting lead lined ring welded onto four tubular legs which shall in turn be welded onto floor pads.

All vertical calorifiers shall have convex bottoms and be fitted with a draw-off cock at the lowest point.

All heater batteries shall be adequately supported within the calorifiers. Where of the 'U' tube pattern, heater batteries shall be suitable for withdrawal from the cylinder and each tube shall be expended directly into a suitable tube plate.

All calorifiers shall be complete with the following mountings and fittings.

- One - safety valve.
- One - thermometer with separate gunmetal pocket.
- One - altitude gauge with red pointer and isolating cock.
- One - gunmetal draincock with loose lever and hose union connection fitted at the lowest possible point of the calorifier.
- One - manhole.
- One - non-return valve on the cold feed connection and each return connection within 300mm of the calorifier.

Both the shell and battery of each calorifier shall be tested to pressure stipulated in 'Commissioning and Testing' Section and three copies of the Test Certificate endorsed by a responsible member of the firm of manufacturers shall be incorporated in the Maintenance Manuals.

Before manufacture of any calorifier commences, triplicate copies of drawings giving full details of each calorifier shall be forwarded for approval.

Each calorifier shall be insulated as specified in the 'Thermal and Acoustic Insulation' Section of this specification.

C7.21 EXPANSION VESSELS

Where more than one domestic hot water service calorifier is installed, and a water pressure booster set provides the system working pressure, a suitably sized expansion vessel shall be connected to the cold feed connection to each calorifier.

Each expansion vessel shall be capable of handling the expansion volume of its associated calorifier when the calorifier is working at maximum duty.



Each expansion vessel shall be complete with a diaphragm, pressure gauge, be suitable for use with domestic hot water systems, and finished in a high standard gloss paint.

C7.22 TERMINATIONS

Each hot water tap or outlet shall be complete with a service valve as detailed in the "Valve" Clause of this Section of the Specification.

Unless specifically stated otherwise, final hot water supply connections to all taps and fittings shall be carried out as part of this section of the works and shall include the provision of suitable connectors.

C7.23 RELIEF VALVES

Relief Valves shall be the spring loaded totally enclosed type, set to discharge at the safe working pressure of the system, calculated in accordance with the formula in BS 759.

Each valve shall be fitted with a drain pipe lead to discharge near floor level, which is provided with a suitable support at the terminal point. The drainpipe shall be of equal bore to the valve.

To prevent the sitting of the valve from being interfered with, the enclosure shall be fitted with a padlock supplied with duplicate keys.

C7.24 CONNECTIONS INTO EXISTING PIPEWORK INSTALLATION

Where connections are made into existing installations, the new pipework shall be flushed and cleaned as described under the 'Flushing, Cleaning and Sterilisation' of Water System clause.

Following the flushing and cleaning process, the new and existing pipework shall be sterilised as previously described.

C7.25 STRAINERS

One strainer shall be installed at the main return header of each system, before all thermostatic valves and pumps and in other locations as shown on the drawings.

Strainers shall be of bronze construction with brass or stainless steel screens with 0.8mm perforations, equal to not less than 3 times the normal bore of the pipe.

Strainers 108mm size and above shall be fitted with an integral drain cock to facilitate drain down prior to screen maintenance i.e., between local isolating valves.

Strainers shall have connections compatible with the pipework specification, be installed in the horizontal plane and between two valves which can be isolated and as described elsewhere in this specification.

Strainers having screwed ends shall have threads complying with BS 21.



C7.26 COPPER ALLOY CHECK VALVES

Copper alloy check valves shall be of the disc check type with screwed plug cover, and suitable for installation in a horizontal pipe line.

Discs shall be integral with a guide pin working within a vented sleeve formed in the plug cover and shall mate with a machined body seating ring. Pipe connections shall be screwed female, or flanged to BS 4504.

C7.27 SELF SEALING TEST POINTS

Self-sealing test plugs shall be provided as follows, together with additional test plugs where indicated on the drawings or elsewhere in this specification.

- Three Off - adjacent to each three port control valve
- Two Off - adjacent to each circulating pump
- One Off - On the secondary flow and return connections to each HWS Generator/Calorifier
- One off - main flow connection to each 3 port control valve/battery

One thermometer and one pressure gauge suitable for use with the test plugs shall be packed in a protective casing and handed to the Services Engineer on completion, together with an adequate supply of any necessary insertion lubricant. Plugs shall be fitted with captive caps for sealing them when not in use and the plugs shall have internal self-sealing devices. The plugs and probes shall be manufactured from materials suitable for the application.

C7.28 IMMERSION HEATERS

Where electric immersion heaters are to be fitted to storage calorifiers or domestic cylinders, these shall be in accordance with BS EN 60335. In particular, the heaters shall be factory fitted with both a control thermostat and an 'over temperature' (high limit) cut out. The 'over temperature' device shall further be of the manual re-set type, set to 15°C above the storage control temperature.

All accessible electrically live parts of the heater assembly shall be suitably shrouded/insulated.



PART C - SECTION 8 COLD WATER SUPPLY

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PART C - SECTION 8

COLD WATER SUPPLY

C8.1 GENERAL

Where applicable the installation shall comply with BS 6700, BS EN 752 and BS EN 1610, together with the requirements of the Water Supply Regulations. All equipment and fittings shall be suitable for use on potable supplies and shall be Water Regulations Advisory Scheme (WRAS) approved.

In addition, the installation shall be compliant with the recommendations set out within the HSE Approved Code of Practice 'The Control of Legionellae Bacteria in Water Systems', together with CIBSE TM13 'Minimising the risk of Legionnaires Disease'.

C8.2 PIPEWORK AND FITTINGS (WITHIN BUILDINGS AND DUCTS)

Pipes shall be of copper to BS EN 1057 R250 (up to and including 159mm), BS EN 12449 (over 159mm) and shall bear the British Standards Institution's Certification "Kitemark", the manufacturer's name and BS/EN number.

Pipes of nominal sizes up to and including 54mm shall be assembled using either pre-soldered capillary fittings, heat free pressure jointed fittings, or push fit fittings. All fittings shall be suitable for the pressure and temperature of the system into which they are being installed, and be assembled and fitted strictly in accordance with the manufacturers instructions.

Pre-soldered capillary fittings shall be lead free copper or copper alloy, tin/copper complying with BS EN 1254. Capillary joints made in chromium plated pipe shall have the plating removed from the length engaged in the fitting socket. On completion, all excess flux and solder shall be removed and chromium plated pipes and fittings shall be washed with soap and warm water to remove heat discolouration.

Heat free pressure jointed fittings shall be manufactured from copper, brass and gunmetal and contain suitable sealing rings.

Push fit fittings shall be manufactured from copper brass and gunmetal, and contain suitable tube stops, sealing rings, release collars, and stainless steel grab rings.

Push fit fittings shall only be used for the final jointing to equipment, and in readily accessible areas. Push fit fittings shall not be installed in concealed locations.

Pipes of nominal sizes larger than 54mm shall be assembled by brazing, using cast high quality lead free brazing metal alloy fittings.

Pipes and fittings shall be supplied with plain finish, except where chromium plated finish is required. Chromium plating shall comply with BS EN 12540.

Changes in direction shall be accomplished using bends with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements use easy transition type with included angle not exceeding 30°, reducing sockets shall be of the eccentric type.

Tees shall be of the swept pattern, except for connections to drains, vents and cold feeds where square tees shall be used.



Bushes shall not be used.

Any screwed joints to valves, gauges, and the like shall be to BS 21 using PTFE tape to BS 7786.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and, where necessary, in the pipework system, to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible on completion of the Contract.

Maintenance joints in pipework up to and including 54mm nominal size shall be copper alloy union couplings, bronze to bronze navy pattern. Flanged maintenance joints shall be used in pipework of nominal sizes greater than 54mm. Flanges shall be solid full face copper alloy, slip-on type suitable for brazing, complying with BS 4504 or BS EN 1092 as appropriate. Flanges used for connections to flanged equipment valves, and the like shall match flanges provided on the equipment. All flanged joints shall be made with full face rubber insertion jointing rings to BS 7874 or BS EN 681 and BS EN 682 as appropriate, brass nuts, bolts and washers, complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure except where specified or indicated on the drawings.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Pipes shall be thoroughly cleaned before erection. Six union or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory the six joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between any service and a service or building element shall be as follows, after allowing for thickness of any insulation:

<u>Between</u>	<u>And</u>	<u>Clearance</u>
Uninsulated or insulated pipework:	Wall, ceiling or soffit :	100mm
	floor :	150mm
Insulated pipework:	Adjacent service (insulated) :	25mm
Insulated pipework:	Adjacent service (uninsulated) :	75mm
Uninsulated pipework	Adjacent service (uninsulated) :	150mm

During erection, open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Except where exposed in rooms, pipework shall be fitted at a gradient not less than 1 in 250.

Visible pipework shall be supported on gun-metal brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the build-in type having properly formed shanks. For thinner walls, screw-fixing brackets shall be used, secured with brass screws by means of expanding plugs, fibre or metal plugs, or purpose designed fixing devices where appropriate.

Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards. Chromium plated brackets, screws, and the like shall be used for supporting chromium plated pipework.



Pipework in other locations shall be installed in accordance with the typical details included in elsewhere in this specification and generally in accordance with BS 3974. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel members shall be accurately drilled to the correct size.

In certain instances, a small pipe may be suspended from a larger pipe, the reverse will not be allowed.

Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
15	1.2	1.8
22 & 28	1.7	2.4
35 & 43	2.0	3.0
54	2.0	3.0
76 & 108	2.4	3.6
133	3.0	3.6
159	3.7	3.6

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

For supports where pipework is insulated see Clause 'Pipework & Ductwork Supports' in the 'Thermal and Acoustic Insulation' Section.

In order to prevent stress fractures occurring in valves and fittings, all materials and components used on the cold water supply shall be confirmed by the manufacturer to be suitable and compatible with the operating temperatures, fluids, and other components of the system. Brass fittings and components should not be used. Acceptable materials would include Copper Alloy, DZR Alloy and Gunmetal.

C8.3 VICTAULIC TYPE FITTINGS (Copper Pipework Systems)

Where specified, copper pipework shall be assembled using specialist fittings for the pipe e.g., Victaulic Coparite fittings. Changes in direction shall be accomplished by using either long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter or Victaulic short radius elbows. For reductions and enlargements easy transition type with included angle not exceeding 30° shall be used. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.



All Victaulic Coparite fittings shall be zinc plated, gold chromate colour.

Earth continuity shall be provided via the couplings. The maximum working pressure shall be 10 bar.

Final connections to air conditioning terminal units (fan coils, VAV units and the like) plus all other pipes and fittings (cold feeds, open vents, drains, overflows and the like) shall be either Victaulic Coparite or copper, to the requirements of BS EN 1057 R250, assembled with tin/copper pre-soldered capillary type fittings to BS 864: Part 2, using bends and square tees.

When the thermal expansion cannot be incorporated within the working limits of the Victaulic joint, then the thermal expansion of pipework shall be absorbed by expansion loops, sets or bellow units. Where no expansion devices are indicated, expansion movement shall be absorbed by changes in direction, whether or not indicated on the drawings. Where necessary, bends shall be incorporated in connections to equipment and in branch connections in mains. Cold draw shall be applied to all expansion devices. Formed expansion loops shall be fabricated from one uncut length of pipe.

Expansion loops and bellows up to and including 50mm shall have welded or grooved ends. All other expansion loops or bellows shall have flanged or Victaulic grooved ends.

C8.4 ANTI-VIBRATION PIPE SUPPORTS

Where pipework is connected to rotating machinery and there is the potential for vibration transmissions via the installation, pipework shall be supported from a bracket arrangement incorporating a suitable spring vibrator isolator. This arrangement shall also be provided where indicated on the drawings.

C8.5 UNDERGROUND PIPEWORK AND FITTINGS (COPPER & DUCTILE IRON)

Pipes up to and including 65mm

Pipes of nominal sizes, up to and including 65mm shall be copper to BS EN 1057 R220, fully annealed and supplied in coils and assembled with copper or copper alloy tin/copper soldered capillary fittings to BS EN 1254. All pipes and fittings shall bear the British Standard Institution's Certification "Kitemark", the manufacturer's name and BS/EN number.

Copper tubes shall be supplied with an extruded seamless polyethylene sheath, colour coded in accordance with the requirements of BS 1710.

Joints and fittings in sheathed pipework shall be completed in accordance with the manufacturer's instructions and wrapped with an adhesive polythene or P.V.C. tape of the same colour as adjacent pipe protection to form a continuous waterproof protection.

Pipes larger than 65mm

Pipes of nominal sizes larger than 65mm shall be of ductile spun iron to BS EN 545, assembled with flexible socket and spigot joints and fittings complete with rubber jointing rings of the push-in type to BS EN 752 and BS EN 1610.



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Where fittings of push-in type are not available, bolted gland joints incorporating rubber jointing rings, spheroidal graphite iron bolts, nuts and washers shall be used. Where applicable, fittings shall comply with BS EN 545 and all joints shall be made in accordance with the manufacturer's recommendations. All rubber jointing rings shall comply with BS 2494 : Part 1, and be stored in a cool, dark, and draught free condition.

All ductile spun iron pipes and fittings shall be coated externally by the manufacturers with hot applied bitumen solution to BS EN 10300 type I, or cold applied to BS 3416 type II suitable for potable water and finally sleeved in polyethylene sheeting to BS 6067. All ductile spun iron pipes and fittings shall have an internal cement mortar lining shall be applied by the manufacturer.

The Local Water Undertaking shall be asked to specify the thickness of the pipework to BS 534 and the cement quality shall be to BS 4027 sulphate resistant.

General

Marker tapes shall be included to differentiate between potable, hydrant, grey water and other non-potable mains.

Plastic warning marker tapes 150mm wide based on BS.1710 identification nomenclature, shall be laid along the full length of the pipework run during backfilling, positioned between 150mm and 225mm below ground level, in order to minimise possible damage to services during any future excavation work.

The guidance in relation to the marking and identification of pipework for reclaimed (Grey Water) systems given in WRAS Information Guidance Note No. 9-02-05 shall be complied with where applicable, subject to agreement with the Engineer.

Changes in direction shall be accomplished using bends with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements use easy transition type with included angle not exceeding 30°, reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions. Maintenance joints are not required in underground pipework.

Maintenance joints in copper pipework shall be copper alloy union couplings, bronze to bronze navy pattern, the coupling nuts being manufactured from non-dezincifiable material. Flanges used for connections to flanged equipment, valves, and the like shall match the flanges provided on the equipment.

All flanged joints shall be made with rubber insertion full face jointing rings to BS 7874 or BS EN 681 and BS EN 682 as appropriate, nuts, bolts and washers complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected. Nuts, bolts and washers for copper alloy flanges shall be of brass, and for iron flanges of stainless steel.

Before making capillary joints, the ends of the pipes shall be made perfectly round, using tools supplied for this purpose by the pipe manufacturer.

Capillary joints shall be made in accordance with the fitting manufacturer's recommendations and on completion, all excess flux and solder shall be removed.



Ends of pipes shall be cleanly cut at right angles to the pipe axis and all the burrs and sharp edges removed. The inside surfaces of pipes and fittings shall be thoroughly cleaned before installation and maintained in a clean condition during pipe laying. Open ends shall be temporarily sealed, using purpose made metal or wood plugs or blank counter flanges. Where necessary, pipework shall be weighted to prevent flotation.

Pipework shall be laid with a continuous fall in one direction to eliminate high or low points in the underground sections. Where practicable, the gradient shall be not less than 1 in 250. Copper pipework shall be laid with slight deviations from the straight to allow for ground subsidence. Pipe entries into buildings shall comply with the recommendations given in BS 6700. The main shall be laid at a minimum depth of 900mm.

Underground pipes entering buildings shall do so at depth not less than 900mm below the outside ground surface and the vertical rise inside the building shall be not less than 750mm inside the building away from the external wall. If a pipe rises from the ground through the floor at any distance less than 750mm from the outside face of any external wall, it shall be insulated from the floor level down to 900mm below the external ground level, with damp, rot and vermin proof insulation, having a minimum thickness of 75mm.

Civil Engineering work concerned in the laying of underground pipework shall comply with the requirements of BS 6700 and BS EN 752 and BS EN 1610. Before pipe laying commences this section of the works shall include responsibility for ensuring that the construction of the trenches, and their depth, line and gradient, comply with these requirements.

Thrust blocks complying with BS Codes of Practice shall be provided at all bends, branches, changes of direction and dead ends before filling and testing the installations.

C8.6 UNDERGROUND PIPEWORK AND FITTINGS (POLYETHYLENE)

The installation shall comply with BS 5041, BS EN 12416, BS 6700, BS EN 752 and BS EN 1610 and Fire Officer's Committee Regulations.

Pipes shall be blue medium density polyethylene for buried potable water distribution systems. Pipes and fittings shall be manufactured and tested in accordance with the Water Research Centre Specification No. 4.32.03 for mains pipe (90mm and above) and 4.32.04 for fusion joints and fittings. Service pipes (20mm-63mm) shall be manufactured in accordance with BS 6572.

Where contaminated ground is present (potentially any development site that is not a 'green-field' site), then the following table shall be consulted to establish what type of pipework material is best suited.



Type of Contaminant	Nature of Contaminant	Examples of Location	Suitable Pipe Material
None	None	Greenfield sites	No special requirements.
Flammable	Methane	Waste sites	Metal pipe when dealing only with Methane.
Toxic	Cyanide, Lead Antimony, heavy metals	Heavy industry	Metal or plastics.
Organics	Tars, Phenols, Hydrocarbons	Garages, petrol stations, coals and gas works	Metal pipes, PE/AL/PE * (Barrier pipe)
Corrosive	Sulphates, high and low Ph	Slag sites, old brickworks ash.	Plastic pipe, plastic coated copper
Organic and Corrosive	Determined from site investigation		Wrapped iron PR/AL/PE *

* At present there is no composite (barrier) pipe currently approved for installation by WRAS, therefore, no composite (barrier) (pipe should be recommended or installed even though there are at least three currently on the market, the most commonly encountered being Protectorline Trigon and Puriton.

All joints in the pipework, other than where valves, hydrants, and the like are installed, shall be made using Electrofusion fittings and completed as recommended by the pipework manufacturer.

The services of the pipework manufacturer shall be engaged to demonstrate on site the correct method of jointing prior to commencement of the site installation.

All joints to isolating valves shall be made using flanged sockets manufactured from high strength aluminium alloy coated internally and externally with a durable layer of rilsan nylon.

All isolating valves, hydrants, and the like shall be flanged to BS 4504 or BS EN 1092 as appropriate; NP16 and all flanged joints shall be made using gaskets as recommended by the pipework manufacturers, and graphite iron nuts, bolts and washers, complying with the requirements of the same British Standard and pressure rating as the flanges being connected.

All materials and workmanship shall conform to British Standard Specifications and the requirements of the local Water Authority and Water Research Centre Codes of Practice, Guidelines and Specifications.

Marker tapes shall be included to differentiate between potable and hydrant mains.

A mesh marker tape 150mm wide having a colour to suit the service installed and made off with a terminal at either end shall be laid along the full length of the pipework run during backfilling, positioned between 150mm and 225mm below ground level, in order to minimise possible damage to services during any future excavation work.



Before fitting, all pipework shall be checked to ensure that it is free from any cuts in the surface or any other malformation, dirt, grit and grease.

Changes in direction shall be accomplished by using bends with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements, easy transition type with included angle not exceeding 30° shall be used, reducing sockets shall be of the eccentric type.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and all the burrs and sharp edges removed.

The inside surfaces of pipes and fittings shall be thoroughly cleaned before installation and maintained in a clean condition during pipe laying. Open ends shall be temporarily sealed, using purpose made metal or wood plugs or blank counter flanges.

Where necessary, pipework shall be weighted to prevent flotation.

Underground pipes entering buildings shall do so at depth not less than 900mm below the outside ground surface and the vertical rise inside the building shall be not less than 750mm inside the building away from the external wall. If a pipe rises from the ground through the floor at any distance less than 750mm from the outside face of any external wall, it shall be insulated from the floor level down to 900mm below the external ground level with damp, rot and vermin proof insulation, having a minimum thickness of 75mm.

Civil Engineering work concerned in the laying of underground pipework shall comply with the requirements of BS 6700, BS EN 752 and BS EN 1610. Before pipe laying commences this section of the works shall include responsibility for ensuring that the construction of the trenches and their depth, line and gradient, comply with these requirements.

Thrust blocks complying with BS Codes of Practice shall be provided at all bends, branches, changes of direction and dead ends, before filling and testing the installations.

The depth and position of underground services shall be fully compliant with the Joint Utility Services guide for laying services.

C8.7 VALVES

Valves shall comply with the following British Standard Specification for the temperature and pressure of the installation:-



Description	British Standard
Ball Valves (Float Operated, up to and including 25mm)	BS 1212
Cast Iron Sluice Valves	BS 5163
Cast Iron Wedge and Double Disc Gate Valves	BS EN 1171
Cast Iron Globe and Globe Stop and Check Valves	BS EN 13789
Cast Iron Check Valves	BS 5153
Copper Alloy Stop Valves (Loose Jumper)	BS 1010 PT.2
Copper Alloy Wedge and Double Disc Gate Valves	BS 5154 Series B
Copper Alloy Check Valves	BS 5154 Series B
Butterfly Valves	BS EN 593
Diaphragm Valves	BS EN 13397
Cast Iron Plug Valves	BS 5158
Cast Iron Ball Valves	BS ISO 7121

Valves of nominal sizes, 54mm and less shall have ends screwed to BS 21 taper thread or shall have capillary ends to BS EN 1254. Larger valves shall have flanged ends, complying to BS 4504 or BS EN 1092 as appropriate and be similar to these selected for the pipework.

Cast iron valves shall not be utilised on pipework of sizes 54mm and less. On sizes larger than this cast iron will only be allowed where they comply with Water Research Centre requirements for potable water, and where they incorporate a Water Research Centre approved lining.

Copper Alloy Stop Valves shall be provided with Capstan heads marked 'C'. All other valves shall be provided with wheel handles. Valves installed in underground pipelines shall be suitable for key operation and shall, where indicated in the schedule, be supplied with surface boxes complying with BS 5834 : Part 2.



Valves shall be installed in positions which permit easy access for operation and maintenance but shall not be installed where a leaking gland may drip on electrical equipment.

Gate valves shall preferably be installed with stems horizontal. Unions incorporated in, or fitted adjacent to valves with screwed or capillary ends, shall be positioned on the "draw-off" side of the valve.

Valves installed in all branch pipework shall be fitted as close to the main as practicable, in order to reduce the length of the upstream "dead leg" to an absolute minimum.

Valve ends shall be sealed at works and the sealing left intact until immediately before installation in the pipeline. Chromium-plated valves shall be protected from damage throughout the Contract period, and chromium plating shall comply with BS EN 12540.

Flow and pressure measurement valves shall be located to ensure manufacturers' recommended straight length of pipe upstream and downstream of valves is provided.

C8.8 DRAIN COCKS

Drain cocks shall be installed on all items of equipment and all low points in the pipeline system and adjacent (within 250mm) to valves isolating sub-circuits to enable the whole, or sections of the system, to be drained down.

Drain cocks installed in the pipework system shall be of 15mm nominal size. Drain cocks at the foot of risers and in Plant Rooms shall be 25mm nominal size. The sizes of other drain cocks are specified with the equipment concerned.

Drain cocks shall be copper alloy of the screwdown pattern to BS 2879. Each drain cock shall have inlet end screwed to BS 21 taper thread, ribbed outlet end suitable for hose attachment and lockshield type head. Three lockshield keys shall be provided for each size of drain cock installed.

Drain cocks shall be fitted clear of pipe insulation and in positions allowing easy operation.

C8.9 AIR ELIMINATORS

Air eliminators shall be suitable for the operating temperature of the particular system in which they are installed and be mounted on air bottles installed at all high points in the pipework system.

Manually operated eliminators shall be 8mm nominal size nickel-plated copper alloy, spoutless, Lockshield type air cocks, with inlet ends screwed to BS 21 taper thread. Air cocks shall be fitted in easily accessible positions, extension pipes being provided where necessary between the connections on the mains and the air cocks. Extension pipework shall be of 8mm nominal size copper tube to BS EN 1057 R220, assembled with capillary fittings to BS EN 1254. In all cases, air cocks shall be arranged to discharge clear of pipe insulation. A total of six Air Cock Keys shall be supplied.



Automatic air eliminators shall be of the float-operated type, having aluminium bronze bodies and stainless steel working parts, 15mm nominal size inlet connections screwed to BS 21 taper thread, and be complete with separate lockshield isolating valves and strainer on inlet. Air release pipes shall be run from the outlet connections to discharge in an external position. Air release pipework shall be of 15mm nominal size copper tube to BS EN 1057 R250, and assembled with capillary fittings to BS EN 1254. Automatic air eliminators shall be installed in positions which permit easy access for maintenance.

Air bottles shall be made from 200mm lengths of 54mm nominal size pipe having inlet connections of 54mm or mains size, whichever is the smaller.

C8.10 TEMPERATURE MEASUREMENT

Provision for temperature measurement in the pipework system shall be made by installing thermometer pockets and thermometers.

Pockets shall be copper alloy screwed to BS 21 and shall be of length and diameter to suit the bulbs of the specified thermometers. Each pocket shall be installed in the pipework at a suitable angle to enable a fitted thermometer to be easily read from floor level, and in such a manner as to provide adequate circulation over the full pocket length. Where necessary, cross pieces of minimum 50mm nominal size shall be installed in the pipework to accommodate the pockets. The entrance to each pocket shall be positioned clear of pipe insulation.

All thermometers shall be mercury in steel direct-mounting type, having a straight rigid bottom entry stem suitable for use with the specified pockets. Dials shall be 100mm diameter calibrated 0-120°C.

Where thermometers are permanently fixed, the gap between thermometer bulk and pocket shall be fitted with suitable oil or grease. Empty pockets shall be fitted with copper alloy screwed plugs.

Provision for temperature measurement shall be provided as a minimum on the incoming mains supply to the development and on the outgoing supply from potable tanks. This shall take the form of self-seal test points. In addition, temperature measurement shall be provided as indicated on the drawings and where specified within the 'particular' part of this specification.

C8.11 PRESSURE MEASUREMENT

Provision for pressure measurements in the pipework systems shall be made by installing gauge connectors and pressure gauges.

Each gauge connector shall comprise a short branch from the main terminating with a gauge cock. Branches shall be of sufficient length to clear pipe insulation. Gauge cocks shall be of copper alloy with lever handles and ends screwed to BS 21 to suit the connections on the specified pressure gauges.

Each connector shall be arranged to allow a fitted gauge to be easily read from the floor level.



All pressure gauges shall be direct mounting bottom inlet Bourdon Tube type, complying with BS 1780 and BS 5235 and having 100mm diameter dials, calibrated in bar to between 1.5 and 2 x the maximum working pressure in the system. Each pressure gauge shall be provided with an adjustable red pointer which, in the case of the permanently mounted gauges, shall be set to indicate the normal working pressure at that point in the system. Where fitted in pressure vessels, clearly mark with maximum permissible working head in accordance with BS 759.

Pressure gauges shall have casings and dials of the same style as thermometers.

Provision for pressure measurement shall be provided as a minimum on the incoming mains supply to the building. This shall take the form of self-seal test points. In addition, pressure measurement shall be provided as indicated on the drawings and where specified within the 'particular' part of this specification.

C8.12 THERMOSTATIC MIXING VALVES

Each mixing valve shall in all respects be as specified in the Domestic Hot Water Services section of this specification under the sub-clause 'Thermostatic Mixing Valves'.

The cold water service connections to each mixing valve shall be complete with the manufacturer's inlet check valve, strainer, and a stopcock as specified under the 'Valve' clause of this section of the specification.

All surface mounted thermostatic mixing valves shall be suitably fixed to the wall with chromium plated brass screws.

All thermostatic mixing valves installed on healthcare projects shall be Type 3, and be manufactured and fixed, in accordance with the NHS Estates specification DO8. 'Thermostatic Mixing Valves (Healthcare Premises)'.

C8.13 COLD WATER STORAGE TANKS

General

Cold water storage tanks shall be designed and installed to be fully compliant with the Water Regulations and the recommendations of the HSE Approved Code of Practice for the control of Legionellae bacteria in water systems.

Each cold water storage tank shall be complete with an overflow pipe and warning pipe in copper as described in the 'Pipework and Fittings' clause of this section of the Specification arranged to discharge in an external position. The overflow and warning pipe shall be turned down inside the tank, terminating 50mm below the water line, and shall terminate externally with a bend facing downwards, and complete with a screened corrosion resistant mesh - 0.65mm maximum opening.

Each warning and overflow pipe shall terminate in a position to be agreed with the Services Engineer.

The inlet cold water feed connection to each cold water storage tank shall be complete with an isolating valve and ball valve. Each ball valve shall be fitted above the overflow outlet connection and have an arm of sufficient length to ensure that the valve closes when the water line in the tank is at the distance specified from the top of the tank.



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The final water discharge position of all main cold water feed inlets to all cold water storage tanks fed from a mains supply shall be in the form of a type 'A' air gap.

Any water storage tank being fed from a main water storage tank shall have a final water inlet discharge point in the form of a type 'B' air gap.

Each tank shall be mounted in a drip tray manufactured from galvanised mild steel of similar construction to one piece tanks, on lead lined supports over the whole of the base. A drain pipe in copper shall be taken from the drip tray to terminate alongside the warning pipe.

Each tank shall be complete with a rigid close fitting and securely fixed removable manway access cover, which excludes light and insects from the cistern but incorporates a screened air inlet corrosion resistant mesh - 0.65mm maximum opening. All fixed covers shall be complete with a 450mm diameter raised manhole sited in an agreed position.

Each tank, on which the distance between the tank room floor level and manway access cover is greater than 1.5M, shall be supplied with a suitable, galvanised after manufacture ladder, to enable personnel to gain easy access to the tank.

All tanks shall be insulated as detailed in the 'Thermal & Acoustic Insulation' section of this Specification.

All connections and access man-ways and the like shall be of sufficient length so as to project clear of the finished face of the storage tank insulation to facilitate ease of disconnection.

Each sectional tank transverse joint and ends shall be adequately supported, and each tank shall be complete with stainless steel internal stays to prevent distortion.

All internal nuts, bolts and washers shall be stainless steel, external nuts bolts and washers shall be mild steel sheradised.

All tanks shall be fitted with a 25mm drain cock, as detailed under the Drain Cock Clause of this section of the Specification.

All tanks shall be clearly labelled as to their function and capacity.

All tanks shall be mounted on a base in accordance with the manufacturer's recommendations, and a demonstration that each tank base is level shall be made to the Services Engineer prior to the commencement of the erection of each tank.

All tanks shall be thoroughly cleaned and washed out prior to commissioning.

Unless specified to the contrary, tanks shall be of GRP construction with fully encapsulated insulation provided as part of the tank construction.

All tanks shall be complete with 1" BSP connections for temperature measurement sensor for remote monitoring.

Cast Iron Sectional Tanks

Each tank shall comply with the requirements of BS 1563.

All connections shall be flanged to BS 4504, single pad type cast on plate.

One coat of boiled linseed oil primer shall be applied at manufacturer's works.



GRP Tanks (One Piece)

Each tank shall be moulded in one piece with top quality polyester resin/glass fibre. An integral welded steel frame shall be encapsulated within the laminate. Deflection of these tanks when full shall be less than 2.5% of the side wall length. Where tanks are to be used for the storage of cold water they shall be suitable for a working temperature of 62°C. When used as a feed and expansion tank they shall be suitable for a continuous temperature of 100°C.

GRP Tanks (Sectional)

Each tank shall be constructed from flanged GRP panels bolted through the flanges sandwiching a mastic strip to provide a watertight seal. Nuts, bolts and washers shall be of stainless steel.

The tanks unless specified to the contrary shall have external flanges and an internal stainless steel reinforcement system.

The tank shall be erected on skeletal RSJ supports to the manufacturer's requirements.

All connections above 50mm shall be provided by the manufacturers, and shall be a flanged pad and double studded. All connections below 50 mm shall be provided by the manufacturer and shall be BSP female connections.

C8.14 FLUSHING, CLEANING & STERILISATION OF WATER SYSTEM

Each system shall be flushed and cleaned in accordance with the principles laid down in the BSRIA Application Guide 1/2001.1 entitled 'Pre-Commission Cleaning of Pipework Systems'.

All recommended reporting procedures, and progressive recording for the flushing, cleaning, and treatment of each system shall be provided as part of this section of the works. A detailed method statement covering the cleaning and flushing process, including coloured schematic drawings illustrating the dynamic flushing flow paths similar to those detailed in the Application Guide shall be provided to the Services Engineer prior to the commencement of the cleaning process. The method statement shall be discussed with the water treatment specialist prior to Tender and any additional equipment, valves and the like, required to comply with this Application Guide 1/2001.1 shall be provided as part of this section of the works.

Chemical cleaning shall be carried out using a suitable cleaning agent incorporating a polymer/dispersant and an inhibitor. This solution shall be circulated around the system for a minimum of 12 hours.

The selected chemicals shall be capable of controlling all corrosive, aggressive and bacteriological agents contained within the water to be used within the system.

Particular attention shall be given to local water conditions, and this section of the works shall include the responsibility to control all adverse conditions including pseudomonas.

Where required by the Local Water Authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

Following Local Water Authority approval, either neutralise and dispose to drain off all waste products, or ensure authorised disposal at registered site.



After flushing and cleaning the complete installation, comprising all pipework, tanks, cisterns and other equipment connected to the Cold Water Supply System, shall be efficiently sterilised before handover.

Sterilisation shall be carried out by the Specialists to the requirements of BS 6700. The sterilisation Specialists shall be informed of all constituent materials in the system, to ensure that suitable chemicals are selected. On completion, the system shall be thoroughly flushed out to remove all traces of sterilising chemicals.

C8.15 PRESERVATION OF WATER QUALITY

1. General

In order to preserve the quality of water this section of the works shall :

provide for all parts of cold water circuits in contact with the water to have clean and disinfected surfaces after being installed.

require all materials specified and used to be proof against the following hazards :-

- (a) dezincification of galvanic action.
- (b) chlorine treatments.
- (c) imparting taste or odour to the water.
- (d) contamination of water by lead, copper or other elements in excess of standards laid down by the EEC, See Clause 6.
- (e) bacterial growth due to nutrients in pipework materials, jointing materials, pastes and compounds, fluxes, solders, thread sealant tapes, gaskets, grommets, tap washers, 'O' rings, gland packings, valve seats, filters, hoses, greases, lubricants, protective coatings or linings.

include for all materials and fittings to be of an approved type as tested and listed by the Water Research Centre, as suitable for potable water and not capable of promoting bacterial growth.

have pipework circuits for cold water run below, or away from, hot pipes to minimise heat gain and keep water temperatures below 20°C to prevent the multiplication of Legionella bacteria.

incorporate backflow prevention devices or air gaps provided as shown on the drawings and specified within this Specification, based on BS 6700 and to BS EN 13076, BS EN 13077 and BS EN 14451 as appropriate.

2. Disinfecting of Cold Water Systems

Disinfection procedures shall :-

-
- be carried out following satisfactory flushing, pressure testing and setting-to-work prior to handover.
- apply to each system including cisterns, vessels, pipework which shall be disinfected with chlorine by either a Specialist organisation certified to BS EN ISO 9002 for this type of work or the Local Water Undertaking.
- follow DoH – HTM 04-01 "The Control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems", Code of Practice, BS 6700 and as



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outlined in the following clauses for new installations and for extended or modified systems. Any variations required shall be specified elsewhere.

- for Healthcare Buildings, adopt all recommendations/requirements set out within the relevant Health Technical Memorandums (HTM's).

Note : Flushing is not a substitute for a high degree of cleanliness during installation.

3. External Mains Disinfection

Note : All chlorination of pipework under pressure from the mains must be carried out in accordance with the requirements of the local Water Undertaking.

External mains disinfection shall :-

- be through suitable valved filling points (at one end of the system) for introducing the chlorous solution.
- have chlorine introduced by means of chemical dosing apparatus connected upstream until a concentration of not less than 20 ppm can be measured along the pipe run of new mains.
- have the main left static for not less than 24 hours (alternatively concentration of 50 ppm for one hour may be used) before flushing through with fresh water until chlorine cannot be detected at a level above that in the water undertaking mains.
- have wash-out valves and valved filling points included in the installation.

Existing mains supplying new distribution systems may require re-chlorination.

Any repairs or insertion at junctions into an existing pipeline shall have the new and existing components disinfected by immersion in a solution of sodium hyperchlorite containing 1000 mg/l of free available chlorine.

4. Distribution Pipework Chlorination

Each distribution system shall :-

- have the mains supply to storage cisterns satisfactorily chlorinated as necessary, and all cisterns cleaned of all visible contaminants before services within buildings are treated.
- have all water drained off and all draw-off points closed and all isolating valves opened except on cistern outflow.
- after flushing, be filled with clean water and chlorinated as required under BS 6700 and the HSE's Approved Code of Practice and Guidance L8 for control of Legionella,
- for Healthcare Buildings, after flushing be filled with clean water and chlorinated as detailed in the DoH HTM 04-01 The Control of Legionella, hygiene, "safe" hot water, cold water and drinking water systems".



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Except : The concentration of chlorine within the cistern(s) and at all taps and outlets shall be 40 to 50 ppm and not 30 ppm as given in the ACoP.

The above procedures shall be applied to all cold water services and to all the secondary circuits of hot water systems before heat is applied and with the water cold. Care shall be taken not to use excessive amounts of chlorine which may affect pipework or other materials. Records must be kept of all procedures, checks, tests and witnessing.

Note : It is essential that the internal coatings of cisterns are thoroughly cured before disinfection takes place and care must be taken not to exceed 50 ppm chlorine concentration.

During chlorination, all taps shall have suitably worded notices on their non use for normal purposes.

5. Prevention of Water Stagnation

This shall provide for the flushing of each system with clean water on a routine basis until handover, generally carried out twice weekly unless otherwise specified.

6. Testing of Water Quality

All systems shall have been satisfactorily set-to-work and disinfected before water samples are taken.

Testing shall :-

- include for analysis of each hot and cold water supply system taken from representative sampling points at draw-off and storage positions with the systems at working temperatures.
- be carried out in accordance with BS 6068 water quality microbiological methods detection and enumeration legionella.
- have all water samples tested for E.Coli and chemical analysis including a copper and lead content. The quality of potable water at outlets (and as sampled) shall be as supplied by the Water Authority and generally to EC Directive, 15th July 1980, 80/778/EEC "Quality of Water intended for Human Consumption". Potable water from a borehole supply shall comply with DOE Circular 25/84 and EC Directive 80/778/ELEC.
- have samples taken and analysed initially as a reference point as agreed with the Services Engineer or his representative.

Generally samples will be taken from:-

Main supply on site
Storage Cistern (Hot/Cold)
H & C Outlets (to be agreed with Services Engineer) in each Department/Area within the building.

The samples shall be analysed by the Public Health Laboratory Service or the local Water Undertakings as specified.



Include for two sets of tests, the first after setting-to-work and disinfecting and the second in conjunction with the handover date and the date for occupation of the premises.

7. Legionnaires Disease Precautions

Shall :-

- be in accordance with HSE's Approved Code of Practice and Guidance L8 for the 'Control of Legionella Bacteria in Water Systems'.
- for Healthcare Buildings, be in accordance with the requirements of DoH HTM 04-01.
- include for taking water samples for Legionellae bacteria from all hot and cold water systems. The method for obtaining samples shall be to the Public Health Laboratory Services requirements.
- provide for the tests to be carried out by the Public Health Laboratory Services on samples taken from representative sampling points when the systems are at working temperature and conditions.
- include for temperature of the water (hot or cold) at the sampling point to be recorded at the time of taking each sample.
- have water samples, for analysis, taken from three hot and three cold water outlets, the location of the outlets to be determined by the Services Engineer.
- provide for the samples and their analysis to be carried out prior to Practical Completion and the Services Engineer notified of the results.

8. Analysis Reports

Shall :-

be discussed by the Services Engineer with the Medical Officer for Infection Control. Where results are not satisfactory, suitable remedial action shall be agreed upon and undertaken at the pipework installer's expense.

C8.16 TERMINATIONS

Each cold water tap or outlet shall be complete with a service valve, as detailed in the Valve Clause of this Section of the Specification.

Unless specifically stated otherwise, final cold water supply connections to all taps and fittings shall be carried out as part of this section of the works and shall include the provision of suitable connectors. WRAS approved, suitably pressure rated flexible connections may be used for this purpose.

C8.17 CONNECTIONS INTO EXISTING PIPEWORK INSTALLATION

Where connections are made into existing installations, the new pipework shall be flushed and cleaned as described under the 'Flushing, Cleaning and Sterilisation of Water System' clause.



Following the flushing and cleaning process, the new and existing pipework shall be sterilised as previously described.

C8.18 WATER METERS

Water meters shall be installed in the positions indicated on the drawings, and the total quantity of water which has passed through the meter shall be recorded on a digital dial indicating the flow in litres.

Each meter shall have flanged or union joints to suit the specification for the pipework in which it is to be installed and be complete with isolating valves on the inlet and outlet connection.

A full bore valved bypass, incorporating a removable flanged spacer section, shall be installed around the meter with the valves being located immediately after the connections are taken off the main.

C8.19 WATER PRESSURE BOOSTER SETS

Packaged automatic water pressure booster sets shall comprise of a number of selected vertical multistage pumps each connected to common suction and delivery copper pipework, factory assembled and tested and be mounted on a common steel baseplate, which in turn shall be mounted on suitable anti-vibration mountings.

Pump sets shall be WRAS approved and be included on their list of approved equipment.

All pumps shall be of either bronze, gunmetal, or stainless steel construction and shall be complete with a mechanical seal and coupled to a totally enclosed fan cooled motor wound for a 415 volts, 3 phase, 50 Hz, electric supply.

All pipework on each set shall be in copper as described in the 'Pipework and Fittings' clause of this section of the specification.

Packaged units designated to run constantly shall be fitted with a small lead pump incorporating a small bore valved bypass to prevent the pump casing overheating during a closed valve condition, whereas packaged units controlled to run intermittently shall incorporate a diaphragm accumulator mounted on the unit base complete with a Butyl or equal flexible diaphragm bag in which the pressurised water shall be stored.

The accumulator shell shall be internally coated suitable for charging with compressed air and be fitted with compressed air connection, safety valve and base flanged connection suitable for inspection of flexible diaphragm bag and water/drain connection.

Each packaged unit shall be complete with an individual control panel mounted on the unit base and shall incorporate the following :-

- (a) The panel shall be suitable for top cable entry with the provision to allow cable looping from one panel to another.
- (b) The following shall be mounted on the front of the panel:-
 - i. Handle of the panel supply 'on-load' isolator
 - ii. Indicator lamps for each of the following :
Panel Supply On



- Control Circuit Fuse Failed
 - 'Run & Trip' for each pump motor
 - Low Water Pumps Cut Off
 - iii. ON/OFF/AUTO selector for each of the pumps
- (c) The following shall be mounted inside the panel, all items being fully shrouded and/or enclosed:-
- i. Panel supply 'on-load' isolator.
 - ii. Control circuit fuse.
 - iii. Three phase fused supply, Star Delta starter and lockable panel service isolator for each pump.
 - iv. Auto changeover to start next stage pump in the event of duty pump trip.
 - v. Outgoing terminals and step-down transformer for external low water cut-out switches.
 - vi. Outgoing terminals and relays with normally open, volt-free contacts for a remote 24v alarm system to operate on any fault and/or when water tank low water pump cut-out switch operates.
 - vii. Outgoing terminals for control circuit to remote normally closed no-volt relay contacts in 'essential supply monitoring relay' to limit number of pumps running in the event of failure of 'non-essential' supply.
 - viii. All necessary relays, terminal blocks, and the like to provide the required plant operation.
 - ix. Timeswitch (required on intermittent unit only).
 - x. Pressure switch incorporating adjustable minimum timer to prevent pump 'hunting'.
- (d) The following items of equipment shall be supplied loose but fitted under this Section of the Works:-
- i. 1 No. Low water safety cut-out switch (break tank type)
 - ii. 1 No. Low water alarm switch

Constant run pump sets shall incorporate a small lead pump running constantly with support pumps being brought into operation in stages by the control pressure switch as the system demand increases.

Intermittently run pump sets shall have equally sized pumps, one of which will act as a base pump, the support pumps being brought into operation in stages by the automatic pressure control switch as the demand increases. This pump set shall also include a diaphragm accumulator which shall provide a quantity of stored pressurised water, thereby permitting the base pump to be automatically switched off during a closed valve condition.

In the event of the failure of the 'non-essential electric supply' each pump set control panel shall be so arranged as to limit the number of pumps running simultaneously when operating from the 'essential supply monitoring relay'.

When low water conditions occur in the break tank this shall be sensed by a low level alarm switch and when extra low water conditions occur this shall be sensed by a safety cut-out switch which shall interrupt the electric supply to all pump motors and bring into action a remote alarm. Each control panel shall facilitate the use of manual start-up of each pump under extra low water conditions.



On restoration of adequate water supply in break tanks following an extra low water condition, each pump set shall start up in sequence and under no circumstances shall all pumps become operational simultaneously.

Each packaged unit shall be complete with individual pump suction and discharge bronze isolating valves, and bronze non-return valves on each pump discharge, pressure stats and pressure gauges, anti-vibration mountings and flexible connections.

The packaged booster units manufacturer shall be responsible for the delivery and installation of each unit and final connection from the suction and delivery pipework to the distribution pipework.

C8.20 STRAINERS

One strainer shall be installed at the main return header of each system, before all thermostatic valves and pumps and in other locations as shown on the drawings.

Strainers shall be of bronze construction with brass or stainless steel screens with 0.8mm perforations, equal to not less than 3 times the normal bore of the pipe.

Strainers 108mm size and above shall be fitted with an integral drain cock to facilitate drain down prior to screen maintenance i.e., between local isolating valves.

Strainers shall have connections compatible with the pipework specification, be installed in the horizontal plane and between two valves which can be isolated and as described elsewhere in this specification.

Strainers having screwed ends shall have threads complying with BS 21.

C8.21 CAST IRON CHECK VALVES

Cast iron check valves shall be of the swinging check pattern with bolted cover and suitable for installations in a horizontal pipe line.

Discs shall be provided with a separate facing ring and shall mate to a renewable body seat ring. The disc/hinge connection shall be such as to ensure seating of the disc. Pipe connections shall be screwed female, or flanged to BS 4504.

C8.22 COPPER ALLOY CHECK VALVES

Copper alloy check valves shall be of the disc check type with screwed plug cover, and suitable for installation in a horizontal pipe line.

Discs shall be integral with a guide pin working within a vented sleeve formed in the plug cover and shall mate with a machined body seating ring. Pipe connections shall be screwed female, or flanged to BS4504.

C8.23 DOUBLE CHECK VALVES AND RPZ VALVES

Spring loaded double check valves shall be installed on all services and items of equipment, necessary for compliance with the Water Supply Regulations.



Each valve shall be WRAS approved under the water byelaws scheme and manufactured in accordance with BS EN 14451 : Part 1.

Each valve shall incorporate a mid point drain plug, be suitable for operating in a service up to a pressure of 21 bar and at a temperature not in excess of 90°C, be suitably sized for the pipework in which it is to be installed and of sufficient duty for the service or equipment being supplied by that valve.

RPZ valves shall be installed where appropriate to meet the requirements of the Water Supply Regulations where a type BA device is required, and shall be commissioned by an Accredited Tester (as published on the WRAS website). The device must be compliant with Regulation 4, and installation guidance is given in WRAS document AIM-08-01.

C8.24 URINAL WATER MANAGEMENT SYSTEM

Every pipe supplying water to a flushing cistern for a urinal, or to a maximum of three flushing cisterns on a long line of urinals with multiple cisterns, shall be fitted with an automatic flow shut off device to regulate the periods during which the cistern may fill and flush in full accordance with the Water Supply Regulations.

All such devices used shall be WRAS approved.

1. Hydraulically Operated Self Contained Water Control Device

Shall comprise :

- a diaphragm operated valve, which when opened allows water to flow into the cistern.
- a hydraulic accumulator which when fully charged will maintain an equal pressure on both sides of the diaphragm.
- an adjuster screw which determines the amount of water discharged into the cistern.

Each unit shall operate by pressure reduction on the inlet side of the diaphragm (by a tap being opened or a toilet flushed) causing an imbalance of pressure across the diaphragm when then temporarily opens the valve.

Each unit shall be selected to suit the operating pressure of the pipework system in which it is to be installed.

An additional hygiene flush attachment shall be provided, where indicated, to enable a flush approximately every 24 hours. This additional attachment shall be adjustable to accommodate local variations in supply pressure.

All applicable pressure, water flow and timing adjustments shall be made to the unit in accordance with the manufacturer's recommendations to optimise its operation.



2. Electrically Operated Self Contained PIR Water Control Device

Shall comprise a solenoid valve and a passive infra red sensor control unit which shall be capable of installation close coupled or adjacent to the valve or remote from the valve.

Each device shall function by detecting the presence of people in the area of the urinals when they enter the field of view of the passive infra red sensor. This shall activate the solenoid valve to allow a regulated flow of water into the cistern for a predetermined time. An inbuilt delay system shall prevent continuous operation of the sensor and an inbuilt hygiene flush feature shall ensure routine flushing approximately every 12 hours, even if nobody is detected during that period.

Each device shall be either battery or mains operated, and suitable for the operating pressure of the pipework system in which it is to be installed.

All applicable pressure, water flow and timing adjustments shall be made to the unit in accordance with the manufacturer's recommendations to optimise its operation.

Mains powered devices shall be tested in accordance with the manufacturer's recommendations and the IEE Wiring Regulations.

C8.25 POINT OF USE PROTECTION

All outlet points connected to a non-dedicated cold water system shall be fitted with an appropriate backflow protection device in compliance with the Water Supply Regulations and local water company requirements.



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PART C - SECTION 9

FIRE PROTECTION

C9.1 GENERAL

Where applicable the installation shall comply with BS 5041, BS EN 671-1, BS EN 12416, BS 9990, BS 6700 and the Fire Officers Committee Regulations, the Water Research Centre Codes of Practice, Guidelines and Specifications and the requirements of the Local Water Authority and CIBSE Guide Book 'E' (Fire Engineering).

C9.2 UNDERGROUND HYDRANT MAIN (POLYETHYLENE AND DUCTILE IRON)

Pipes up to and including 65mm

All pipes of nominal size up to and including 65mm shall be manufactured in accordance with BS 6572, and be blue medium density polyethylene for buried water distribution systems. Pipes and fittings shall be manufactured and tested in accordance with the Water Research Centre Specification No. 4.32.03 for mains pipe (90mm and above) and 4.32.04 for fusion joints and fittings.

All joints in the pipework, other than where valves or hydrants are installed, shall be made using Electrofusion fittings and completed as recommended by the pipework manufacturer.

The services of the pipework manufacturer shall be engaged to demonstrate on site the correct method of jointing, prior to commencement of the site installation.

All joints to isolating valves and hydrants shall be made using fittings manufactured from high strength aluminium alloy, coated internally and externally with a layer of Rilsan nylon.

Pipes larger than 65mm (Polyethylene)

All pipes and fittings of nominal size over 65 mm for buried water distribution systems shall be either MDPE or HPPE (Unless the route of the pipe is through contaminated ground) manufactured and tested in accordance with the Water Research Centre Specification No. 4.32.09 and 4.32.13 for mains pipe (90mm and above) and 4.32.04 for fusion joints and fittings.

All joints in the pipework, other than where valves or hydrants are installed, shall be made using Electrofusion fittings and completed as recommended by the pipework manufacturer.

The services of the pipework manufacturer shall be engaged to demonstrate on site the correct method of jointing, prior to commencement of the site installation.

All joints to isolating valves and hydrants shall be made using fittings manufactured from high strength aluminium alloy, coated internally and externally with a layer of Rilsan nylon.

Pipes larger than 65mm (Ductile Iron)

Pipes of nominal sizes larger than 65mm shall be of ductile spun iron to BS EN 545. Where vitaculic fittings are not available, bolted gland joints incorporating rubber jointing rings, spheroidal graphite iron bolts, nuts and washers shall be used.



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Where applicable, fittings shall comply with BS EN 545 and all joints shall be made in accordance with the manufacturer's recommendations. All rubber jointing rings shall comply with BS EN 681-1:1996, and be stored in a cool, dark, and draught free condition.

All ductile spun iron pipes and fittings shall be coated externally by the manufacturers with hot applied bitumen solution to BS EN 10300 type I, or cold applied to BS 3416 type II suitable for potable water and finally sleeved in polyethylene sheeting.

General

MDPE and HPPE pipework shall be provided with isolation valves to allow pressure testing to take place in accordance with the manufacturer's recommendations and BS EN 805 in sections of no more than 1000m.

Where contaminated ground is present (potentially any development site that is not a 'green-field' site), conventional MDPE pipe work shall not be used. Under these circumstances, a multi-layered co-extruded MDPE pipe installation shall be used incorporating an impermeable metallic barrier wrapped around a central core of MDPE conforming to BS 6572 with an external blue MDPE coating or any other suitable material conforming to the guidance contained within the WRAS Information and guidance note No 9-04-03.

Marker tapes shall be included to differentiate between potable and hydrant mains.

Plastic warning marker tapes 150mm wide shall be laid along the full length of the pipework run during backfilling, positioned between 150mm and 225mm below ground level, in order to minimise possible damage to services during any future excavation work.

Before fitting, all pipework shall be checked to ensure that it is free from any cuts in the surface or any other malformation, dirt, grit and grease.

Changes in direction shall be accomplished by using bends with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements, easy transition type with included angle not exceeding 30° shall be used, reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and all the burrs and sharp edges removed.

The inside surfaces of pipes and fittings shall be thoroughly cleaned before installation and maintained in a clean condition during pipe laying. Open ends shall be temporarily sealed, using purpose made metal or wood plugs or blank counter flanges. Where necessary, pipework shall be weighted to prevent flotation. Where practicable, the gradient shall be not less than 1 in 250.

Civil Engineering work concerned in the laying or underground pipework shall comply with the requirements of BS 6700 and BS EN 752 and BS EN 1610. Before pipe laying commences this section of the works shall include responsibility for ensuring that the construction of the trenches, and their depth, line and gradient, comply with these requirements. Pipework shall be laid with a continuous fall in one direction to eliminate high or low points in the underground sections.

Underground pipes entering buildings shall do so at a depth not less than 900mm below the outside ground surface and the vertical rise inside the building shall be not less than 750mm inside the building away from the external wall.



If a pipe rises from the ground through the floor at any distance less than 750mm from the outside face of any external wall, it shall be insulated from the floor level down to 900mm below the external ground level, with damp, rot and vermin proof insulation, having a minimum thickness of 75mm.

Thrust blocks complying with BS Codes of Practice shall be provided at all bends, branches, changes of direction and dead ends, before filling and testing the installation. The main shall be laid at a minimum depth of 900mm.

Valves shall be flanged cast iron sluice valves complying with BS 5163. Valves shall be suitable for key operation and shall, where necessary, be supplied with surface boxes complying with BS 5834 : Part 2. Valve ends shall be sealed at works and the sealing left intact until immediately before installation in the pipeline.

Underground fire hydrants shall be installed with outlets at approximately 300mm below ground level. Hydrant valves shall comply with BS 5163 and may be either of the sluice valve type or of the screw-down type. All hydrants shall be fitted with an automatic frost valve and those hydrants having bottom inlets shall be connected to the mains by means of a hydrant bend with supporting shoe.

All hydrants shall be supplied with surface boxes having covers and clear opening as specified in BS 750 to suit the type of hydrant installed. Surface box frames shall be 114mm deep when installed in pathways and 150mm deep when installed in roadways.

The size of main and position of each hydrant shall be marked by an indicator plate complying with BS 3251. Plates shall be mounted on concrete posts or fixed to a wall or fence. Concrete posts shall be arranged so that the base of the post is at least 500mm below ground level and the top of the indicator plate is 750mm above ground level. Indicator plates fixed to a wall or fence shall be between 1m and 2m above ground level.

Three black mild steel keys, complete with turning levers, shall be supplied for operating valves and hydrants, and four ring handle keys shall be supplied for lifting the covers of the surface boxes.

C9.3 INTERNAL HOSE REEL INSTALLATIONS

Pipes shall be of copper to BS EN 1057 R250 (up to and including 159mm), BS EN 12449 (over 159mm) and shall bear the British Standards Institution's Certification "Kitemark", the manufacturer's name and BS/EN number.

Pipes of nominal sizes up to and including 54mm shall be assembled using either pre-soldered capillary fittings, heat free pressure jointed fittings. All fittings shall be suitable for the pressure and temperature of the system into which they are being installed, and be assembled and fitted strictly in accordance with the manufacturers instructions.

Heat free pressure jointed fittings shall be manufactured from copper, brass and gunmetal and contain suitable sealing rings.

Pipes of nominal sizes up to and including 54mm shall be assembled with lead free copper or copper alloy, tin/copper pre-soldered capillary fittings, to BS EN 1254 bearing the British Standards Institution's Certification "Kitemark". Capillary joints shall be made in accordance with the Fitting Manufacturers' recommendations.



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Chromium plated pipe shall have the plating removed from the length engaged in the fitting socket. On completion, all excess flux and solder shall be removed and chromium plated pipes and fittings shall be washed with soap and warm water to remove heat discolouration.

Pipes of nominal sizes larger than 54mm shall be assembled by silver brazing, using cast high quality lead free brazing metal alloy fittings.

Pipes and fittings shall be supplied with plain finish, except where chromium plated finish is required. Chromium plating shall comply with BS EN 12540.

Changes in direction shall be accomplished using bends with a centre line radius/nominal bore of not less than 1.5 dia. For reductions and enlargements use easy transition type with included angle not exceeding 30°, reducing sockets shall be of the eccentric type.

Tees shall be of the swept pattern, except for connections to drains and vents where square tees shall be used.

Bushes shall not be used.

Any screwed joints to valves, gauges, and the like shall be to BS 21 using PTFE tape to BS 7786.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and, where necessary, in the pipework system, to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible on completion of the Contract.

Maintenance joints in pipework up to and including 54mm nominal size shall be copper alloy union couplings, bronze to bronze navy pattern. Flanged maintenance joints shall be used in pipework of nominal sizes greater than 54mm. Flanges shall be solid full face copper alloy, slip-on type suitable for brazing, complying with BS 4504 or BS EN 1092 : PN10 as appropriate. Flanges used for connections to flanged equipment valves, and the like shall match flanges provided on the equipment. All flanged joints shall be made with full face rubber insertion jointing rings to BS 7874 or BS EN 681 and BS EN 682 as appropriate, brass nuts, bolts and washers, complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure except where specified or indicated on the drawings.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Pipes shall be thoroughly cleaned before erection. Six union or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory the six joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

The minimum clearance between any service and a service or building element shall be as follows, after allowing for thickness of any insulation:

<u>Between</u>	<u>And</u>	<u>Clearance</u>
Uninsulated or insulated pipework:	Wall, ceiling or soffit :	100mm
	floor :	150mm
Insulated pipework:	Adjacent service (insulated) :	25mm
Insulated pipework:	Adjacent service (uninsulated):	75mm
Uninsulated pipework	Adjacent service (uninsulated):	150mm



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During erection, open ends shall be temporarily sealed using purpose made caps, plugs or flanges.

Except where exposed in rooms, pipework shall be fitted at a gradient not less than 1 in 250.

Pipework visible in rooms shall be supported on gun-metal brackets of the schoolboard or single ring type. Where the walls are 150mm thick or more, brackets shall be of the build-in type having properly formed shanks. For thinner walls, screw-fixing brackets shall be used, secured with brass screws by means of expanding plugs, fibre or metal plugs, or purpose designed fixing devices where appropriate. Soft wood and plastic plugs shall not be used. Brackets shall not be fixed to skirting boards.

Pipework in other locations shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel members shall be accurately drilled to the correct size.

In certain instances, a small pipe may be suspended from a larger pipe, the reverse will not be allowed.

Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
28	1.7	2.4
35 & 43	2.0	3.0
54	2.0	3.0
76 & 108	2.4	3.6
133	3.0	3.6
159	3.7	3.6

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

For supports where pipework is insulated see Clause 'Pipework & Ductwork Supports' in the 'Thermal and Acoustic Insulation' Section.

C9.4 HOSE REELS (AUTOMATIC)

All hose reels shall be of the 'drum' pattern to BS EN 671-1, BS EN 12416 : Part 1 and BS 9990, be automatic in operation such that when approximately 3m of hose is pulled off, water enters the reel, and be complete with a copper alloy-chromium plated jet/spray nozzle to BS 336.



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Each reel shall have a 19mm. smooth bore, braided red rubber hose to BS EN 694:2001 AND BS EN 1947: 2002 which shall not be subject to kinking.

Each hose reel shall be mounted and fixed in the manner recommended by the manufacturer.

The cold water inlet connection to each hose reel shall be complete with a gate valve to BS 5154 complete with wheel handle and lock up attachment.

Each hose reel shall be complete with the manufacturer's instruction plate of laminated plastic which, where appropriate, shall include a nozzle fixing clip.

Each fixed hose reel shall be complete with the manufacturer's guide assembly to enable the hose to be withdrawn in any direction through 180°.

Before connecting the hose to the cold water main, the main shall be flushed out.

C9.5 HOSE REELS (NON-AUTOMATIC)

All hose reels shall be of the "drum" pattern to BS EN 671-1, BS EN 12416 : Part 1 and BS 9990, non- automatic in operation, complete with a copper alloy-chromium plated jet/spray nozzle to BS 336.

Each reel shall have a 19mm smooth bore, braided red rubber hose to BS EN 694:2001 AND BS EN 1947: 2002 which shall not be subject to kinking.

Each hose reel shall be mounted and fixed in the manner recommended by the manufacturer.

The cold water inlet connection to each hose reel shall be complete with a gate valve to BS 5154 complete with wheel handle.

C9.6 DRY RISER INSTALLATIONS

Pipes shall be of galvanised mild steel to BS EN 10255 heavy quality assembled with screwed joints using galvanised wrought steel fittings to BS EN 10241, or Victaulic type jointed

Screwed Joints

Pipes and fittings shall be screwed to BS 21 taper thread, and screwed joints shall be made with jointing compound and hemp all to BS 6956 or BS EN 751-1, as appropriate, or PTFE tape to BS 7786. Changes in direction shall be made using long radius bends formed from black mild steel pipe to BS EN 10255 heavy quality galvanised after manufacture to the requirements of BS EN ISO 1461. Formed bends shall show no reduction in the pipe bore and the inside of bends shall be free from ripples. Bends shall be galvanised before screwing.

Maintenance joints shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and where necessary, in the pipework system to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible on completion of the Contract.



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Maintenance joints in pipework up to and including 50mm nominal size and in connections to equipment with screwed ends shall be galvanised socket unions to BS EN 10241.

Flanged maintenance joints shall be used in pipework of nominal sizes greater than 50mm. Flanges used for maintenance joints shall be galvanised carbon steel screwed boss type to BS EN 1515 or BS EN 1092, as appropriate.

Flanges used for connections to flanged equipment, valves, and the like shall be galvanised carbon steel screwed boss type matching the flanges provided on the equipment. All flanged joints shall be made with full face corrugated brass joint rings coated on both sides with jointing compound all to BS 6956 or BS EN 751-1 as appropriate. Bolts, nuts and washers shall be black mild steel, sheradised in accordance with BS 4921 and complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected.

Pipework shall not be jointed within the thickness of walls or floors and shall not be embedded in the building structure except where specified or indicated on the drawings.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Any pipe cut, or after construction, any area of damaged pipework shall be made good in accordance with BS EN ISO 1461, using metallic zinc rich priming paint to BS 4652. Pipes shall be thoroughly cleaned before erection. Six screwed or flanged joints shall be dismantled for inspection. If the workmanship is satisfactory the six joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

Victaulic Joints

Unless otherwise specified, all galvanised mild steel pipework shall be assembled using fittings of the same thickness as the pipe being, Victaulic grooved fittings or Victaulic shouldered fittings to BS 1965 : Part 1, and shall be jointed by Victaulic couplings.

Changes in direction shall be accomplished by using either long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter or Victaulic short radius elbows.

For reductions and enlargements easy transition type with included angle not exceeding 30° shall be used. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.

All Victaulic fittings shall have a galvanised finish.

Joints for all metallic pipework shall be provided with the means for electrical continuity within the pipework system in accordance with the current IEE Wiring Regulations.

The minimum clearance between the surface of a pipe and finished building surface or other pipes or insulation shall be 100mm.

During erection, open ends shall be temporarily sealed using plugs, caps or flanges.

Pipework shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel shall be accurately drilled to the correct size.



Pipes shall be supported at intervals not exceeding the following:-

Nominal Pipe Sizes mm	Maximum Distance Between Supports Metres	
	Horizontal Pipes	Vertical Pipes
20 & 25	2.5	3.0
32	2.8	3.0
40 & 50	3.0	3.7
65 & 80	3.7	4.5
100	4.0	4.5
125 & 150	4.5	5.5

Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical mains.

Inlet breechings shall comply with BS 5041 : Part 3 and be of gunmetal construction suitable for horizontal or vertical mounting and include the following:-

Scheduled number of inlet connections, each incorporating a non-return valve and having a 65mm male instantaneous coupling, complying with BS 336, fitted with gunmetal blank cap and chain.

Outlet connection, of size indicated in the schedules, flanged to BS EN 1515 or BS EN 1092 as appropriate.

25mm gunmetal drain valve fitted with gunmetal blank cap and chain.

Each breeching piece shall be housed in an inlet box, complying with the requirements to BS 5041 : Part 5, and shall be of the dimensions recommended for the size of breeching piece concerned.

Outlet valves complying with BS 5041 : Part 2, shall be 65mm nominal size of gunmetal construction and fitted with wheel handles. Each valve shall have inlet end flanged to BS EN 1515 or BS EN 1092 as appropriate and outlet end with 65mm female instantaneous coupling, complying with BS 336, fitted with a gunmetal blank cap and chain.

Where outlet valves are housed in outlet boxes, these boxes shall be manufactured to the requirements of BS 5041 : Part 4 and be of the dimensions for the size of valve concerned.

Where outlet valves are not accommodated in boxes, each valve shall be secured in the closed position by means of a padlocked leather strap looped through the wheel handle and bracket attached to the valve body.

A drain valve shall be installed at the lowest point of each dry riser. Drain valves complying with BS 1010 shall be 25mm nominal size gunmetal globe valves and have a wheel handle and ends screwed to BS 21 taper thread. The outlet end shall be fitted with a gunmetal blank cap and chain.



An automatic air release valve shall be installed at the highest point of each dry riser. Air release valves shall be of all gunmetal construction and 25mm nominal size with inlet ends screwed to BS 21 taper thread.

C9.7 VALVES

Valves shall be installed in the pipework system where indicated on the drawings and elsewhere, where specified.

Unless otherwise specified, valves shall comply with the following British Standard Specifications for the temperature and pressure of the installation:-

Description	British Standard
Cast Iron Wedge and Double Disc Gate Valves	BS EN 1171 : 2002
Cast Iron Globe and Globe Stop and Check Valves	BS EN 13789
Cast Iron Check Valves	BS EN 12334 : 2001
Copper Alloy Wedge and Double Disc Gate Valves	BS EN 12288 : 2003
Copper Alloy Check Valves	BS 5154 Series B
Copper Alloy Globe Valves	BS 5154 Series B
Cast Iron Ball Valves	BS ISO 7121

Valves of nominal sizes, 54mm and less shall have ends screwed to BS 21 taper thread or shall have capillary ends to BS EN 1254. Larger valves shall have flanged ends, complying to BS EN 1515 and be similar to those selected for the pipework.

Cast iron valves shall not be utilised on pipework of sizes 54mm and less. On sizes larger than this cast iron valves will only be allowed where they comply with Water Research Centre requirements for potable water, and where they incorporate a Water Research Centre approved lining.

Valves shall be installed in positions which permit easy access for operation and maintenance but shall not be installed where a leaking gland may drip on electrical equipment. Gate valves shall preferably be installed with stems horizontal. Unions incorporated in, or fitted adjacent to valves with screwed or capillary ends, shall be positioned on the draw-off side of the valve.

Valve ends shall be sealed at works and the sealing left intact until immediately before installation in the pipeline.



C9.8 DRAIN COCKS

Drain cocks shall be installed on all items of equipment and at all low points in the pipeline system and adjacent (within 250mm) to valves isolating sub-circuits to enable the whole, or sections of the system, to be drained down.

Drain cocks installed in the pipework system shall be of 15mm nominal size. Drain cocks at the foot of risers and in Plant Rooms shall be 25mm nominal size. The sizes of other drain cocks are specified with the equipment concerned.

Drain cocks shall be copper alloy of the screwdown pattern to BS 2879. Each drain cock shall have inlet end screwed to BS 21 taper thread, ribbed outlet and suitable for hose attachment and lockshield type head. Three lockshield keys shall be provided for each size of drain cock installed.

Drain cocks shall be fitted clear of pipe insulation and in positions allowing easy operation.

C9.9 AIR ELIMINATORS

Air eliminators shall be suitable for the operating temperature of the particular system in which they are installed and be mounted on air bottles installed at all high points in the pipework system.

Manually operated eliminators shall be 8mm nominal size nickel-plated copper alloy, spoutless, lockshield type air cocks, with inlet ends screwed to BS 21 taper thread. Air cocks shall be fitted in easily accessible positions extension pipes being provided where necessary between the connections on the mains and the air cocks. Extension pipework shall be of 8mm nominal size copper tube to BS EN 1057 R220, assembled with capillary fittings to BS EN 1254. In all cases, air cocks shall be arranged to discharge clear of pipe insulation. A total of six air cock keys shall be supplied.

Automatic air eliminators shall be of the float-operated type, having aluminium bronze bodies and stainless steel working parts, 15mm nominal size inlet connections screwed to BS 21 taper thread, and be complete with separate lockshield isolating valves and strainer on inlet. Air release pipes shall be run from the outlet connections to discharge in an external position. Air release pipework shall be of 15mm nominal size copper tube to BS EN 1057 R250 engraved with manufacturer's name and BS number and assembled with capillary fittings to BS EN 1254. Automatic air eliminators shall be installed in positions which permit easy access for maintenance.

Air bottles shall be made from 200mm lengths of 54mm nominal size pipe having inlet connections of 54mm or mains size, whichever is the smaller.

C9.10 COLD WATER BOOSTER SET

Packaged automatic pressure booster sets shall comprise pumps, accumulator and starter mounted on a common base-plate and complete with interconnecting copper pipework, isolating and non-return valves, anti-vibration mountings and pressure control switches.

The booster set shall comprise the following :-



- (a) One lead pump shall operate from a pressure switch when water is required to the system. A pressure accumulator shall provide a small quantity of stored pressurised water to cater for small demands. When the system pressure drops to a predetermined level the lead pump shall operate and switch off when the system demand has been satisfied and the accumulator replenished.
- (b) Support pumps which, in the event of the lead pump being unable to satisfy the system, shall start on pressure control to supplement the lead pump. As the demand is reduced the support pumps shall switch off first and then the lead pump as described above. In the event of the lead pump failing then the support pump will operate.
- (c) One standby pump shall be incorporated which shall start automatically should the support pump fail.

Each pump shall be single stage, close coupled, back pullout horizontal centrifugal type. The pump casing shall be of close-grained cast iron, the impeller of bronze and the shaft of chrome steel. Corrosion resistant mechanical seals shall be fitted.

Rubber flexible suction delivery and recirculation connections shall be provided on each booster set, having ends flanged to BS EN 1515 or BS EN 1092 as appropriate and shall be entirely suitable for the operating pressures and temperatures as detailed in this Specification.

Each pump shall be isolated from the common baseplate by suitable anti-vibration mountings. These shall be selected by the supplier to suit the operating weight and frequency of the pumps.

The pressure sensing controller shall be a diaphragm operated type with heavy duty microswitches.

C9.11 FLUSHING & CLEANING OF PIPEWORK SYSTEM

Each system shall be flushed and cleaned in accordance with the principles laid down in the BSRIA Application Guide 1/2001 entitled 'Pre-Commission Cleaning of Water Systems'.

All recommended reporting procedures, and progressive recording for the flushing, cleaning, and treatment of each system shall be provided as part of this section of the works. A detailed method statement covering the cleaning and flushing process, including coloured schematic drawings illustrating the dynamic flushing flow paths similar to those detailed in the Application Guide shall be provided to the Services Engineer prior to the commencement of the cleaning process. The method statement shall be discussed with the water treatment specialist prior to Tender and any additional equipment, valves, and the like required to comply with Application Guide 1/2001 shall be provided as part of this section of the works.

Chemical cleaning shall be carried out using a suitable cleaning agent incorporating a polymer/ dispersant and an inhibitor. This solution shall be circulated around the system for a minimum of 12 hours.

The selected chemicals shall be capable of controlling all corrosive, aggressive and bacteriological agents contained within the water to be used within the system. Particular attention shall be given to local water conditions, and this section of the works shall include the responsibility to control all adverse conditions including pseudomonas.



Where required by the Local Water Authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.

Following Local Water Authority approval either neutralise and dispose to drain off all waste products, or ensure authorised disposal at registered site.

C9.12 GASEOUS AND WATERMIST EXTINGUISHING SYSTEMS

Where Specialist Extinguishing Systems are specified to be used, the Contractor is required to purchase appropriate equipment only from those specialists who can provide evidence that the equipment is fully compatible with the proposed application.

All specialist suppliers of Extinguishing Systems must provide proof of compliance with the relevant regulations and approvals, including approval by Loss Prevention Council.

The systems must be designed, manufactured and installed under the close supervision and control of the specialist supplier who will be required to issue a certificate confirming the system has been designed, manufactured, installed and commissioned to achieve compliance with the recognised approval authority.

The Contractor is responsible for the co-ordination of the Specialist Extinguishing Systems with all other associated buildings and engineering components, including the provision of all ancillaries such as power supplies and water supplies to achieve a fully functional system.

C9.13 SPRINKLER SYSTEMS

Where Specialist Sprinkler Systems are specified to be used the Contractor is required to purchase appropriate equipment only from those specialists who can provide evidence that the equipment is fully compatible with the proposed application.

All specialist suppliers of Sprinkler Systems must provide proof of compliance with the relevant regulations, BS EN 12416 : Part 2 and BS 9990 or BS EN 12845, plus approvals including approval by Loss Prevention Council and where applicable the Employer's insurer.

The systems must be designed, manufactured and installed under the close supervision and control of the specialist supplier who will be required to issue a certificate confirming the system has been designed, manufactured, installed and commissioned to achieve compliance with the recognised approval authority (LPC 1048).

C9.14 FOAM DISTRIBUTION INSTALLATION

Pipes shall be of galvanised mild steel to BS EN 10255 medium quality assembled with screwed joints using galvanised wrought steel fittings to BS EN 10241. Pipes and fittings shall be screwed to BS 21 taper thread and screwed joints shall be made with jointing compound and hemp to BS 6956 or PTFE tape to BS 7786.

Changes in direction shall be made using long radius bends formed from black mild steel pipe to BS EN 10255 medium quality, galvanised after manufacture to the requirements of BS EN ISO 1461. Formed bends shall show no reduction in the pipe bore and the inside of bends shall be free from ripples. Bends shall be galvanised before screwing.



Flanged maintenance joints shall be installed where necessary to allow for easy erection and dismantling of the installation. Flanges shall be galvanised carbon steel screwed boss type to BS EN 1515. Flanged joints shall be made with joint rings coated on both sides with jointing compound all to BS 6956 or BS EN 751-1 as appropriate. Bolts, nuts and washers shall be black mild steel, sheradised in accordance with BS 4921 and complying with the requirements of the same British Standard and pressure rating or table as the flanges being connected.

Pipework shall not be joined within the thickness of walls or floors and shall not be embedded in the building structure except where specified or indicated on the drawings.

Ends of pipes shall be cleanly cut at right angles to the pipe axis and shall be reamed to remove burrs. Any pipe cut or, after construction, any area of damaged pipework shall be made good in accordance with BS EN ISO 1461, using metallic zinc rich priming paint to BS 4652.

Pipes shall be thoroughly cleaned before erection.

The minimum clearance between the surface of a pipe and finished building surfaces or other pipes or insulation shall be 100mm.

During erection, open ends shall be temporarily sealed using plugs, caps or flanges.

Pipework shall be supported in accordance with the standard details listed in Part 'D' or with the details indicated on the drawings. The actual arrangements of supports to be used shall be submitted for comment before manufacture and installation.

Holes required in mild steel angle or channel shall be accurately drilled to the correct size.

Pipes shall be supported at intervals not exceeding 3.7m for horizontal pipes and 4.5m for vertical pipes. Supports shall be arranged as near as possible to pipe joints and each support shall carry its share of the load. The total weight of vertical pipes shall be carried at the base of the riser. Branch pipes shall not be used to support vertical pipes.

Inlet adaptors complying with BS 336 shall be housed in inlet boxes complying with the requirements of BS 5041 : Part 5, having dimensions recommended for the number of adaptors accommodated.

Foam spreaders shall be manufactured of cast iron and have inlet screwed to BS 21 taper thread.

C9.15 SMOKE VENTILATION

Smoke Control Systems shall follow the general guidance given in CIBSE Guide Book 'E' (Section 7). Compliance is required where applicable with :

- NFPA 92A
- NFPA 92B
- BS 5588
- BS 7346
- BS EN 12101
- BRE / FRS 258

The requirements for smoke ventilation are usually bespoke and as such any particular requirements for this project will be indicated in Part D.



PART C - SECTION 10 MAINS GAS

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PART C - SECTION 10

MAINS GAS

C10.1 GENERAL

Where applicable, the installation shall comply with BS EN 752, BS EN 1610, BS EN 1266, BS 6173, BS 7977-2 and the Gas Safety (Installation & Use) Regulations 1994 (SI No. 1866 : 1994).

C10.2 INTERNAL GAS PIPEWORK AND FITTINGS

Pipes of nominal sizes up to and including 150mm shall be of mild steel to BS EN 10255 heavy quality. Pipes of larger sizes shall be seamless carbon steel to BS 3601 (Grade 320) having the following minimum wall thicknesses:-

Nominal Pipe Sizes mm	Wall Thickness mm
200	6.3
229 to 300	8.0

Pipes and fittings in circulating systems shall have black finish.

Mild steel pipework shall be assembled using welding fittings to BS EN 10253-1 and BS EN 10253-2, of the same thickness as the pipe, and shall be jointed by welding in running lengths, except in occupied rooms 50mm and below. Changes in direction shall be accomplished using long radius elbows with a centre line radius/nominal bore of not less than 1.5 diameter. For reductions and enlargements use easy transition type with included angle not exceeding 30°. Reducing sockets shall be of the eccentric type. Tees shall be of the swept pattern, bushes shall not be used.

Visible pipework, up to and including 50mm shall be assembled using malleable cast iron screwed fittings to BS EN 10242 Design Symbol A. Elbows and swept tees shall be used.

Maintenance joints in internal pipework shall be fitted in the pipe connections to all items of equipment, valves, and the like which are not provided with flanges or unions and, where necessary, in the pipework system to allow for easy erection and dismantling of the installation. Maintenance joints shall be positioned where they will be accessible upon completion of the contract. Maintenance joints in pipework up to and including 50mm nominal size and in connections to equipment with screwed ends shall be made by using unions.

Maintenance joints in internal pipework 65mm and above and to equipment with plain ends shall be made by using flanges.

Flanged connections in mild steel pipelines shall be made using carbon steel boss welding flanges to BS 4504 or BS EN 1092 as appropriate.

Flanged joints shall be made with full faced brass corrugated joint rings coated on both sides with jointing compound all to BS 5292 and black steel bolts, nuts and washers, complying with the requirements of the same British Standard and Pressure rating as the flanges connected.



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Connections to equipment with screwed connections shall be made using union connectors.

Screwed connections shall be made with suitable jointing compound (e.g., Boss Gastite). Under no circumstances shall standard boss white be used on any part of the installation. Hemp is to be used as reinforcement on pipe sizes of 50 mm and above.

Unions in mild steel pipelines shall be malleable iron flat seated with soft gaskets.

Pipework after cutting shall be free from burrs, rust, scale and other defects and shall be thoroughly cleaned before erection.

Six joints shall be dismantled for inspection, and if the workmanship is satisfactory, the joints shall be reassembled; if not, all joints shall be dismantled, corrected and the pipework reassembled.

Open ends left during the progress of the work shall be blanked off with purpose-made metal or wood plugs.

Pipework shall be installed to maintain a minimum clearance of 100mm between the pipework and wall finish or adjacent insulation and 150mm between electrical cables and conduits, and the like.

All pipework shall have a gradient to the recommendations given in the BS Code of Practice in order to facilitate the drainage of the system.

Where changes in the pipe level occur, provision shall be made for the collection and removal of condense water and any obstruction which may occur in the system.

Joints shall not be made within the thickness of any wall, floor or ceiling, and pipework shall not be embedded within the building structure.

Pipe supports shall be arranged at intervals not exceeding the following:-

<u>Size of Pipe (mm)</u>	<u>Horizontal (mm)</u>	<u>Vertical (mm)</u>
15	1800	2400
20	2400	3000
25	2400	3000
32	2700	3000
40	3000	3600
50	3000	3600
65	3600	4500
80	3600	4500
100	3900	4500
125	4500	5400
150	4500	5400

Supports shall be arranged as near as possible to each joint and each support shall take its due proportion of the pipe weight.

Vertical rising pipes shall be supported at the base to withstand the total weight of the riser. Branches from risers shall not be used as a means of support for the riser.



Where exposed in rooms, pipework up to 65mm nominal bore shall, where practicable, be supported in accordance with BS 1494 on black japanned malleable iron longshank schoolboard clips or single rings with fishtailed tubular insert, built into walls at a level to cause no interference with the skirting feature.

Where it is required that pipework should be secured to skirting boards or where pipes are secured to wooden partitions, black japanned screw-on schoolboard clips shall be used.

On walls too thin for the use of longshank clips, screw-on schoolboard clips secured by Rawlbolts, Rawlplugs or similar fixings shall be used.

Pipework in other locations shall be installed in accordance with the typical details included in Part 'D'. The actual arrangements of supports to be used shall be submitted for comments before manufacture and installation.

Holes required in mild steel angle or channel shall be accurately drilled to the correct size.

In certain instances a small pipe may be suspended from a larger pipe; the reverse shall not be allowed.

C10.3 UNDERGROUND PIPEWORK AND FITTINGS

The installation shall comply with British Gas Documents IM/16 - December : 1988, BGC/PS/PL2 - Part 1 : Pipework, BGC/PS/PL2 - Part 2 or PL3 : Fittings, and BGC/PS/V7 - Part 7 : Pipe markings and valves.

All underground pipework and fittings shall be run in yellow medium density polyethylene, jointed with Electrofusion fittings, all as recommended by the pipework manufacturer. The pipe shall be laid with not less than 600mm of cover on a 150mm bed, a total surround and a 150mm topping of sand, stone dust or small pea gravel, depending upon the water table of the site, the backfill shall be sifted and graded and compacted in layers.

A yellow metal mesh marker tape 150mm wide and made off with a terminal at either end shall be installed 200mm above the entire length of the buried gas main to enable the route of the pipe to be identified in the future.

The section of pipe from the meter outlet to the underground section and from the buried main into the building shall be carried out using heavyweight mild steel with welded joints. Wavin Limited couplers shall be used to join the materials and the buried lengths of steel pipework shall be wrapped with two layers of Denso tape.

Operatives fully trained in the installation of fusion welded joints, and the like for use with this material shall be employed. The Services Engineer shall, upon request, be provided with confirmation that the operative has attended a suitable training course.

In order to reduce the possibility of cross contamination, all MDPE gas pipes shall be installed a minimum of 600mm from any potable cold water pipe.

C10.4 VALVES AND PLUG COCKS

Valves and plug cocks shall be of the type approved by the relevant Gas Board.

All valves shall be closed by turning the spindle in a clockwise direction.



Plug cocks shall be fitted in pipework up to and including 40mm and fullway gate valves 50mm and above.

All valves and cocks up to and including 65mm diameter shall have ends screwed BS 21 and valves over 65mm diameter shall have ends flanged to BS 4504 or BS EN 1092 as appropriate.

Isolating valves or cocks shall be installed on each branch and sub-main.

Cocks shall be provided on the connections to each item of equipment.

A union shall be provided adjacent to each screwed valve where they are not integral with the valve. Each union shall be fixed on the 'system' as opposed to the 'meter' side of the valve. Three valve keys to suit each valve size shall be provided.

Cocks shall have cast-iron or gunmetal bodies and gunmetal working parts. Plugs for cocks shall be ground-in type, with drop handles for sizes up to 10mm and with forged mild steel loose keys for sizes above 10mm.

Fullway gate valves shall have cast-iron bodies with gunmetal seatings and gunmetal working parts. Glands shall be a good sliding fit in stuffing boxes and on spindles and shall be machined all over. Stuffing boxes shall be properly packed. Screwed joints between valve bodies and covers shall be a good fit when assembled dry and shall be made with jointing material. Holes in covers or in gate nuts for the screwed portion of spindles shall have full threads and shall be tapped to a distance not less than the diameter of the spindle. Screwed portions of the spindle shall be a good fit when assembled. Spindles shall be fitted with wheel handles.

All cocks and valves shall be fitted in accessible positions.

C10.5 DRAIN POINTS

Drain points shall be provided at all low points of the system and at the bottom of each riser and consist of a plugged tee.

Syphon boxes on pipes fitted with plugs shall be supplied in positions necessary to facilitate draining.

C10.6 PRESSURE MEASUREMENT

Provision for pressure measurement in the pipework system shall be made by installing gauge connectors and pressure gauges.

Each gauge connector shall comprise a short branch from the main terminating with a gauge cock. Branches shall be sufficient length to clear pipe insulation. Gauge cocks shall be of copper alloy with lever handles and ends screwed to BS 21 to suit the connections on the specified pressure gauge. Each connector shall be arranged to allow a fitted pressure gauge to be easily read from floor level.

All pressure gauges shall be direct mounting bottom inlet Bourden Tube type, complying with BS 1780 and BS 5235 and having 100mm diameter dials, calibrated in bar to between 1.5 and 2 x the maximum working pressure in the system. Each pressure gauge shall be provided with an adjustable red pointer which, in the case of the permanently mounted gauges, shall be set to indicate the normal working pressure at the point in the system.



Pressure gauges shall have casings and dials of the same style and finish as the thermometers.

C10.7 CORROSION PROTECTION

Pipes which pass through or are in contact with any material likely to cause corrosion shall be adequately protected throughout the area of contact by means of wrapping the pipe with two layers of 'Denso' tape.

C10.8 CONNECTIONS TO GAS FIRED EQUIPMENT

All items of gas fired equipment shall be tested by a CORGI registered person who shall be required to make the requisite adjustment to the governors and other appropriate parts of each item. A certificate shall be obtained from the CORGI registered person to the effect that this testing and adjusting has been satisfactorily carried out, and forwarded to the Services Engineer for record purposes. A copy of this certificate shall be included in the Operating and Maintenance Manual.

The CORGI registered person shall also check the whole of the gas installation before it is handed over, a certificate of worthiness obtained from them and forwarded to the Services Engineer for record purposes. A copy of this certificate shall be included in the Operating and Maintenance Manual.

Each gas appliance shall be fitted with a suitable governor and flame failure device.

C10.9 GRAPHIC DISPLAY

A line diagram of the system included in the Works shall be prepared and mounted at an agreed point, close to the primary meter or alternatively adjacent to the emergency control valve at the point of entry to the Works covered by this contract.

This graphic display shall illustrate the installation in diagrammatic form and show all valves, pressure test points, condensate receivers and electrical bonding. Small diameter services below 25mm are not required to be illustrated.

The diagram shall be produced on a laminate plastic sheet with the system colour coded as installed. All lettering shall be clearly displayed.

A sample of the graphic display shall be submitted for examination prior to manufacture.

C10.10 INSPECTION BY CORGI REGISTERED PERSON

A comprehensive inspection and commissioning of the gas installation shall be carried out by a CORGI registered person as part of this section of the works. This is to ensure that the installation complies with all Current Codes of Practice, Standards and Regulations.

A written report shall be provided by the CORGI registered person upon completion of all tests and be included in each copy of the Maintenance Manual.



C10.11 BOILER HOUSE OR PLANTROOM ISOLATION AND LABELS

Unless otherwise specified an emergency shut off valve shall be provided immediately after the gas main enters the plantroom and operated by emergency push buttons and heat sensors. A label having 50mm high red letters on a white background stating 'Emergency Gas Shut Off for Plantroom', shall be fixed above each push button. A similar label shall also be provided fixed to the Gas Meter House door stating 'Gas. Shut Off Inside'.

C10.12 CONFINED SPACE VENTILATION

It shall be the responsibility of this section of the works to provide and ensure that any ceiling void, roof space, service duct, and the like containing gas pipework is adequately and properly ventilated.

Details of the proposed method of achieving adequate ventilation shall be discussed and agreed with the Architect and Services Engineer prior to commencement of the work on site.

C10.13 GAS METERS

Gas meters shall be installed in the positions indicated on the drawings, and these shall allow for the total quantity of gas which passes through the meter, to be recorded on a digital dial which shall indicate the total flow rate of gas in meters cubed.

On installations suitable for connection to systems incorporating a BMS system each meter shall be complete with an impulse transmitter giving 1 pulse per 100 litres of gas flow.

Each meter shall have flanged or union joints to suit the specification for the pipework in which it is to be installed, and be complete with isolating valves on the inlet and outlet connection.

Each meter shall be preceded with the manufacturers recommended inline filter assembly.

A full bore valved bypass, incorporating a removable flanged spacer section shall be installed around each meter, with the valves being located immediately after the connections are taken off the main.

C10.14 GAS BOOSTERS

(Check with gas provider before specifying)

Gas boosters shall be installed in accordance with British Gas Publication IM/16 'Guidance Notes on the Installation of Gas Pipework Boosters and Compressors in Customers Premises'.

C10.15 INSTALLATION OF GAS WITHIN CATERING ESTABLISHMENTS

The installation shall comply with BS 6173.



Unless otherwise specified an automatic electric isolation valve system shall be installed fitted with a shielded emergency stop button in a readily accessible position near the exit from the catering area. A label having 50mm high red letters on a white background stating "EMERGENCY GAS SHUT OFF FOR KITCHEN" shall be fixed above the push button.

Electric isolation valves shall conform to BS EN 161.

An automatic system of proving that all downstream gas supplies to the burners and pilots have been turned off shall be employed prior to the valve being energized to re-open, however, a proving system may not be needed if all burners are protected by a full flame safeguard system.

The gas supply system shall be interlocked with any mechanical ventilation supply or extract system in conjunction with the requirements of the Standard for Kitchen Ventilation Systems DW/171.

At locations where an automatic electric gas valve system can be reset, a notice shall be affixed stating "IN THE EVENT OF AN EMERGENCY, THE GAS ISOLATION VALVE MUST BE CLOSED. ALL DOWNSTREAM BURNERS AND PILOT VALVES ON APPLIANCES MUST BE TURNED OFF PRIOR TO ATTEMPTING TO RESTORE THE SUPPLY. AFTER EXTENDED SHUT-OFF, PURGE BEFORE RESTORING GAS".



PART C - SECTION 12 VENTILATION AND AIR CONDITIONING

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PART C - SECTION 12

VENTILATION AND AIR CONDITIONING

C12.1 GENERAL

The installation shall comply with BS 5720. This standard has been withdrawn by BSI, but in terms of this specification it shall remain applicable until such time as an appropriate new standard is published.

C12.2 SHEET METAL DUCTWORK

All ductwork shall be manufactured and installed by firms who are members of the Heating and Ventilating Contractors Association specialising in this particular trade.

The construction and internal cleanliness of all ductwork systems prior to commissioning shall be in accordance with the Specifications for Sheet Metal Ductwork DW/144 and Guide to Good Practice Internal Cleanliness of New Ductwork Installations DW/TM2 (Advanced), published by the Heating and Ventilating Contractors Association unless amended by this Specification.

All ductwork installed in systems serving kitchens shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association.

All ductwork shall be zinc coated steel constructed from hot dip galvanised steel to BS EN 10142 grade DX51D+Z coating type Z275.

All ductwork subjected to a working negative or positive static pressure of 500Pa, or a velocity not exceeding 10m/s shall be Class A.

All ductwork subjected to a working positive static pressure of 1000Pa or negative static pressure of 750Pa, or a velocity not exceeding 20m/s shall be Class B.

All ductwork subjected to a working positive static pressure of 2000Pa or negative static pressure of 750Pa, or a velocity not exceeding 40m/s shall be Class C.

Rectangular ducts up to 600mm shall have sheets of minimum thickness of 0.8mm, 601mm to 1600mm shall have a minimum thickness of 1.0mm and over 1600mm shall have a minimum thickness of 1.2mm. Circular and flat oval ducts shall be spirally-wound with a minimum sheet thickness of 0.8mm.

All supporting members shall be isolated from the ductwork by a lining of 6mm thick rubber secured to the support by means of adhesive.

For supports where ductwork is insulated see Clause 'Pipework and Ductwork Supports' in the 'Thermal and Acoustic Insulation' Section.

Supports and drop rods shall be clear of the ducts and not built into acoustic/thermal insulation.

After construction any area of damaged ductwork coating and also joints shall be made good in accordance with BS EN ISO 1461 using metallic zinc rich priming paint to BS 4652.



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Ductwork erected external to the buildings shall be galvanised after manufacture, and be hipped to the middle in order to shed water.

Ductwork with internal applied protective finishes shall have the treatment and the method of application to the ductwork in accordance with the protective finish manufacturer's recommendations.

Flanged joints secured by set screws/nuts shall be provided for connecting the ductwork to flanged items of plant, builders work frames and where removable sections of ductwork are required.

Flange set screws shall be not less than 6mm dia. and sheradised in accordance with BS 4921.

Branch connections on kitchen ductwork extract systems shall be flush on the underside.

Open ends of ducts shall be covered and protected during erection to prevent ingress of dirt and rubbish.

Care shall be taken to ensure that all joint sealing solvent vapours are dispersed from each ductwork system.

Where moisture is present, the ducting shall be arranged to ensure drainage of any entrained moisture between equipment and sealed drain points. On kitchen extract systems ductwork from canopies shall be installed with a 1:50 slope back to the canopy.

Where ductwork passes through or terminates in roofs it shall be fitted with trimming angle and weather cravat to ensure weatherproof fitting to the building structure.

Where ductwork passes through a wall, floor, roof, and the like a galvanised sleeve of adequate clearance shall be provided, stemmed with slag wool to prevent air movement and transmission of noise/vibration between duct and sleeve.

Ductwork shall not come in direct contact with the building fabric except in cases of fire dampers, silencers and builders frame.

All Class B and Class C ductwork shall be pressure tested for air tightness before being covered by the building structure, false ceilings or insulation, to the requirements of Heating & Ventilating Contractors Association 'A Practical Guide to Ductwork Leakage Testing' DW/143 and to the pressures given in Table 32. The air leakage limits shall be as detailed in table 1 of DW/144, for the appropriate Class of Ductwork. On low pressure systems smoke tests shall be carried out to the requirement of the Services Engineer.

Holes shall be provided in the ductwork to accommodate thermostats, and the like specified under automatic control equipment, and these shall be fitted with screwed bushes brazed into the side of the ductwork.

Test points shall be provided in the ductwork system for complete balancing of the system, at each side of all equipment and upstream of all dampers. All holes shall be 25mm diameter and provided with an effective seal.

The Services Engineer shall be consulted when considering any change of section from that shown on the drawings.



Access and cleaning doors shall be fitted in the ductwork, and located not more than 6m apart, except on ductwork below 600mm x 450mm in size where they shall be no greater than 3m apart. Each access door shall be located in the ductwork, such that it is fully accessible, and adjacent to the following positions:-

- (a) At each side of all heating and cooling batteries for the purpose of inspection and cleaning of the finned tubes.
- (b) At each side of all filters if required for ease of access in removal of maintenance of the filters or parts of the filter.
- (c) At each side of all attenuators.
- (d) At each side of steam humidifiers.
- (e) At each air flow sensor position.
- (f) At one side of all dampers.
- (g) At each side of turning veins.
- (h) At each side of tee junctions.
- (i) At each side of bends.
- (j) As required for access to working parts and replacement of thermal links in fire dampers.
- (k) At the base of all vertical rising ducts to give access for cleaning.

Access doors in plant areas shall be hinged and in other areas shall be non-hinged.

Access doors in plantrooms shall be 1350mm x 500mm wide unless restricted by ductwork size in which case they shall be as large as possible. These doors shall be double-skinned with insulation between each skin. Doors external to the plant areas shall be 400 x 400mm clear unless this size is too large for the duct, in which case the door shall be as large as possible, but a minimum of 300mm x 200mm.

Access doors/panels on kitchen extract systems shall be installed on the side of the ducts and shall be at least 40mm above the bottom of the duct.

Where access doors are included in insulated ductwork systems, they shall be insulated to a similar standard of insulation as the adjacent insulation, with the adjacent insulation shaped to allow easy opening of the door.

Access door entry shall not be restricted by other services or building components.

Allowance shall be made for the removal and reinstatement of all access doors for final inspection, and at any time during the commissioning of each system.

The ductwork shall be adequately reinforced around each aperture and access door to prevent distortion, and the duct floor shall be reinforced to take the weight of an average adult male, where personnel entry to the duct is involved.

C12.3 DAMPERS

All dampers shall be in accordance with DW/144.

All dampers in ductwork up to and including size 300 x 300mm or 315mm diameter shall be of the single bladed doubled skin pattern.

All dampers in ductwork of size greater than 300 x 300mm or 315mm diameter shall be of the opposed blade multi-blade pattern.



Single bladed dampers shall consist of two plates of the same thickness of material as that from which the associated duct is made, and be rigidly fixed to each side of the operating spindle the ends of which shall be housed in brass or nylon bearings. These dampers shall be fitted with a locking device, position indicator and rubber sealing ring.

Multi-leaf regulating and isolating rectangular dampers, electrically, pneumatically or manually operated, shall be of the double skin multi-leaf opposed aerofoil blade pattern.

Damper blades shall be constructed of material that shall not rust or be corrosion resistant.

C12.4 IDENTIFICATION OF DUCTWORK

Each range of ductwork shall be identified in accordance with Appendix B - Identification of Ductwork of DW/144 and indicating the direction of air flow, area served, zone served and plant number.

C12.5 CLEANING OF PLANT & DUCTWORK

Each item of plant and range of ductwork shall be cleaned out prior to commissioning in accordance with the requirements of the Heating & Ventilating Contractors Association 'Guide to good Practice, Cleanliness of Ventilation Systems' TR17, and this shall be demonstrated to the Services Engineer by the removal of all access openings for inspection of each system.

Care shall be taken to ensure all joint sealing solvent vapours are dispersed from each ductwork system.

C12.6 FLEXIBLE DUCTWORK CONNECTIONS

Flexible fabric ductwork connections in accordance with DW/144 shall be used for connecting to various terminal units and equipment subject to vibration, and for final connections to air diffusers, registers, and plenum boxes.

All flexible ductwork connections shall be installed in straight lengths only, and the length of each flexible ductwork connection shall be kept to a minimum, and shall not, under any circumstances, exceed 250mm. The fire resistance of each flexible ductwork connection shall be in accordance with the Fire Regulations, and shall also meet the requirements of air tightness of DW/143. Each joint shall be suitable for the temperature and pressure of the system in which they are installed and have minimum frictional resistance.

Where the adjoining ductwork or equipment is insulated, the flexible ductwork shall be similarly insulated and cut ends suitably sealed and secured with metal bands.

C12.7 FLEXIBLE JOINT CONNECTIONS

Flexible joint connections in accordance with DW/144 shall be used for connections at building expansion joints, and fan inlet and outlet joints.



All flexible joints shall be installed, and the like in straight lengths only, and the length of each flexible joint shall be kept to a minimum, and shall not, under any circumstances, exceed 250mm. The fire resistance of each flexible joint shall be in accordance with the Fire Regulations, and shall also meet the requirements of air tightness of DW/143. Each joint shall be suitable for the temperature and pressure of the system in which they are installed and have minimum frictional resistance.

Flexible joints of rectangular construction shall be manufactured from lead loaded vinyl coated glass fabric or equal and approved secured in a workmanlike manner with bolted flanges and metal flats or metal clips.

C12.8 KITCHEN EXTRACT HOODS AND CANOPIES

The construction and installation of all kitchen extract hoods and canopies shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association, and be complete with :-

- (a) Rigidly formed and supported independently of ductwork and suspended ceiling.
- (b) Drip gutter all round with plugged drain point.
- (c) Where detailed in fire risk areas the fire resistance shall comply with BS 476 : Part 7, Class I, and BS 476 : Part 3, Class AA without suffix.
- (d) Constructed from ultra fine grained Grade 304 stainless steel to BS 1449 : Part 2, polished on both sides and having a minimum thickness of 1.0mm.

C12.9 EXTERNAL LOUVRES

These shall be as follows:-

- (a) Provided with bird/vermin screen.
- (b) Large acoustic louvres shall be of modular construction to facilitate easy site handling.
- (c) Louvres shall be constructed of extruded aluminium.
- (d) Flanged with lipped edge.
- (e) Provided with rubber strip weather seal around flange.
- (f) Fixed to frame with cadmium plated screws.
- (g) Have facility provided to allow easy cleaning of bird/vermin screen.

C12.10 F.A.I./EXHAUST CHAMBER LININGS

These shall be as specified or as shown on the drawings.

C12.11 FIRE DAMPERS

Fire dampers shall be a minimum size of 300mm x 300mm and as follows :-

- (a) Dampers and frames shall maintain their fire resistance when exposed to the heating conditions specified in BS ISO 10294-1 -2 and -3 classification E for a minimum period of 2 hours.



- (b) The construction and corrosion resistance of dampers and frames shall comply with the recommendations given in BS EN 12101-6. Damper units shall be fixed to the building structure by one of the methods recommended in BS EN 12101-6.
- (c) Fire dampers shall be of a type in which the blades are recessed to provide 100% free area in the open position.
- (d) The damper blades shall be retained by a self latching removable release mechanism cassette, operating at a temperature of approximately $72^{\circ}\text{C} \pm 4^{\circ}\text{C}$ which shall ensure the closure of the stainless steel curtain under full fire conditions.

All damper blades shall be housed in a galvanised steel fully welded spigotted type casing suitable for square, rectangular, or flat oval connections.

- (e) Dampers shall incorporate testing and reset facilities, and indication that the damper is closed.
- (f) Fire dampers shall comply with the Authority having jurisdiction over the fire protection arrangements in the building.
- (g) The correct operation of the fire dampers shall be checked, proved, and demonstrated before hand over.

C12.12 MOTORISED FIRE/SMOKE DAMPERS

Motorised fire/smoke dampers shall be a minimum size of 100mm x 100mm and as follows :-

- (a) Power operated dampers shall be fully compliant to BS ISO 10294-1, -2 and -3, classification E.S. for a minimum period of 4 hours, and shall comply to class A and B of Eurovent Document 2/2 and test procedures for Classes A, B and C of HVCA ductwork specification DW/144.
- (b) The damper blades shall be aerodynamic, double skin, to BS EN 10088-2 (430) ferritic 75mm wide construction stainless steel, which shall interlock to form a positive smoke and fire resisting shield. A synthetic seal to ensure low closed blade smoke leakage, shall be incorporated within the blade profile.

Stainless steel blade end bearings and peripheral gasketing shall maintain the low closed blade smoke leakage, whilst allowing for expansion under full fire conditions.

- (c) An external visual blade position indicator of open/closed status of the damper shall be fitted.
- (d) The dampers shall be operated by one of the following externally mounted control mode actuators:-
 - (i) Manual reset fusible link closure.
 - (ii) Auto reset 24 Volt AC or DC closure.
 - (iii) Auto reset 220-240 Volt AC closure.
- (e) Smoke dampers shall comply with the requirements of the Authority having jurisdiction over the fire/smoke protection arrangements of the building.
- (f) The correct operation of all motorised fire/smoke dampers shall be checked, proved, and demonstrated before handover.



C12.13 SMOKE DIVERTING DAMPERS

Smoke diverting dampers shall be provided on recirculation air systems to automatically divert any smoke contaminated return air to the outside of the building in the event of a fire, and be arranged so that the normally open smoke diverting damper on the return air branch to the input unit closes and all the return air is exhausted through the extract fan.

Each smoke diverting damper shall be operated by means of the fire alarm and smoke detection system, provided by others. Each smoke diverting damper shall be complete with a self contained unit incorporating a green light to indicate damper open, and red light and audible alarm to indicate damper closed.

Each damper unit shall be complete with all necessary ancillary wiring, and contacts for remote positive indication of damper status.

C12.14 SOUND ATTENUATORS

Purpose built attenuators type tested to BS EN ISO 7235 at the manufacturer's works or an approved testing laboratory and certificates shall be provided and installed.

Unless indicated otherwise on the drawings, attenuators shall be installed with a straight run of inlet and outlet ductwork of length 5D or 4M (whichever is the greater) where D = maximum duct dimension.

The lining or attenuator infill shall be of mineral fibre mat to BS 3958 : Part 5, faced one side with a bonded white glass cloth, the whole being capable of resistance to mould, vermin, moisture and odours and non-combustible to BS 476 : Part 4, with fire propagation index of not more than $I = 12$ and $i = 6$ to BS 476 : Part 6. The mat shall be bonded to the inner surface with all joints sealed and further secured under a perforated non-corrodible metal cover over the glass cloth facing.

Each attenuator casing shall be constructed of galvanised steel sheet metal.

Each attenuator unless specified otherwise shall be complete with the following :-

- (a) Galvanised flanged duct connection at each end of the casing except where high frequency terminal attenuators are specified.
- (b) High frequency terminal attenuators shall have spigot duct connections.
- (c) Rubber gasket between attenuator angle and ductwork.
- (d) Adequate support preferable in walls to prevent transmission of vibration in the ductwork system, and isolated from the building fabric to prevent transfer of structure borne noise or vibration.
- (e) All sheet metal seals and joints (including longitudinal joints) sealed with sealants having proven properties of adhesion and elasticity, and applied in accordance with the manufacturer's instructions to completely seal the joint and make it air tight under the working temperature and pressure conditions.
- (f) Construction matched to pressure of adjacent ductwork.



Attenuators installed on cooling tower systems, kitchen extract systems, or other systems containing moist or grease laden air, shall incorporate suitable protective linings to ensure satisfactory operation of the attenuator, and ensure that there is no grease impregnation into the acoustic media. All attenuators shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association.

Attenuation media and insulation materials used on kitchen ventilation systems shall be non-fibrous having a Class 1 spread of flame.

C12.15 DUCTWORK ATTENUATION

Where specified, sound attenuation shall be by means of acoustically lined ductwork or mitred bends, with increased dimensions to suit insulation thickness and maintain the cross sectional area of the stated ductwork size in all other instances. This lined ductwork or mitred bends shall comply with the requirements, including testing, stated in the "Sound Attenuators" Clause of this Section of the Specification.

Attenuation media and insulation materials used on kitchen ventilation systems shall be non-fibrous having a Class 1 spread of flame.

Circular ductwork shall not be lined.

Care shall be taken not to damage acoustic lining of ductwork when it is being cleaned, and any such damage caused will be completely rectified under this Section of the Works.

C12.16 AIR DIFFUSERS, GRILLES AND REGISTERS

Each air diffuser or grille shall be as follows:-

- (a) Kitchen grilles shall have quick release sub-frames.
- (b) Provided with a set of keys for the manual setting of the dampers.
- (c) Provided with all necessary suspension brackets, screws, suitable attachments, bolts, nuts and washers to support the grilles to the recommendation of the manufacturer.
- (d) The grilles where attached to ductwork shall be supported independently of the ceiling.
- (e) Non-vision grilles shall have horizontal inverted 'V' section blades.
- (f) Be manufactured of extruded aluminium.
- (g) Be complete with opposed blade damper.
- (h) Air terminal ratings shall be as determined by the methods of testing and rating given in BS EN ISO 5135.
- (i) Continuous lengths of linear diffuser shall incorporate suitable key locking facilities between each length to ensure a neat continuous appearance.
- (j) All ducted grilles shall be supplied with a manufacturer's plenum box, complete with circular spigot connection for use with flexible ductwork.

C12.17 AIR EVACUATION FLAPS

Each air evacuation flap shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Adjustable to selected positive pressure required to open them.



- (c) Complete with angle frame for fixing and with sealing strip to prevent staining of walls.
- (d) Each flap shall be checked in situ for correct operation during commissioning.

C12.18 SELECTION OF FANS

Each fan shall be selected to ensure that the specified duty is not on or close to, or at the top or close to the top of, a particular performance curve.

Each installed fan shall have a body and impeller which is capable of handling an increase in pressure which is a minimum of 15% above the specified total pressure at the design volume.

The motor of each installed fan shall have a size/rating which is a minimum of 15% greater than that required for the selected unit body and impeller.

For belt driven fans, notice should also be taken of the clause headed 'Belt Driven Equipment' contained within Part 'B' of this Specification.

Notice should be taken of the Equipment Selection Clause contained within Part B of this part of this Specification, which requires a margin on all motors at the specified duty.

All fans installed in extract systems serving kitchen installations, shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association and be suitable for the operating temperatures of the particular system to which they are connected.

C12.19 WINDOW MOUNTED FANS

Each window fan shall be complete with the following:-

- (a) Automatic draught proof shutter and exterior grille.
- (b) Electric socket and speed control unit.
- (c) Window gaskets.

Full details of the hole required for the fan unit shall be provided.

Window fans shall comply with the requirements of BS EN 498.

C12.20 WALL MOUNTED FANS

Each wall mounted fan shall be complete with the following:-

- (a) Finished to prevent rusting.
- (b) Fixing frame of flanges and wall sleeve.
- (c) Protection guards.
- (d) Fans shall be capable of the specified performance when tested in accordance with BS ISO 14695 and, where applicable, shall comply with the requirement of BS 5285.



C12.21 ROOF EXTRACT FANS

Each roof extract unit shall be complete with the following:-

- (a) Aluminium Construction.
- (b) Suitable fixings as recommended by the fan manufacturer.
- (c) Protection guard.
- (d) Automatic shutters.
- (e) When connected to ductwork systems maintenance access door in ductwork.
- (f) Bird screens.

C12.22 CENTRIFUGAL FANS

Each fan shall be as specified or as shown on the drawings complete with the following:-

- (a) Capable of the specified performance when tested in accordance with BS ISO 14695, using a backward curve or aerofoil bladed impeller.
- (b) Fan casing constructed of mild steel plates with necessary stiffeners and base angle frame to prevent drumming and vibration.
- (c) External lubrication of bearing, unless fan is equipped with sealed bearings.
- (d) Drain and plug fitted in the fan casing at the lowest point.
- (e) Fan casing designed for ease of removal of impeller.
- (f) Outlet shall be flanged and inlet flanged or spigotted as indicated.
- (g) Impeller shall be keyed to a substantial steel shaft and the impeller and shaft shall be statically and dynamically balanced and tested before leaving the manufacturer's works.
- (h) Shaft bearing shall be truly aligned and rigidly mounted.
- (i) Motor complete with slide rail allowing positive adjustment of the tension on the V belt drives.
- (j) Holding down bolts for fan motor and guard positioned to ensure correct alignment.
- (k) Metal guards easily removable protecting all rotating parts and covering belts and pulleys. The guards shall be complete with access doors and taking tachometer readings and allow for adjustment of motor on the slide rails.
- (l) V-belt drive complete with taper variable pitch lock pulleys set at the mid point in accordance with BS 3790. Due allowance shall be made for final adjustment of the pulleys to obtain the required duty.
- (m) Where duplicate motors are supplied and fixed the spare motor shall be complete with slide rails and be fixed in position ready for operation. The guard shall be designed to protect both directions of drive and be easily removed and refitted on change-over of drive motors and belts.
- (n) Large fans shall be fitted with lifting bolts or other lifting facilities.
- (o) On large fans, fitted with inspection and access door in casing in accessible position.
- (p) Flexible connections shall be fitted on the outlet and inlet of the fan.
- (q) Where anti-vibration mountings are required they shall be as specified or as shown on the drawings.
- (r) Each fan, together with motor(s) and guards shall be mounted on a common channel iron base frame which shall be isolated from the floor by suitable anti-vibration mountings.
- (s) Visible inspection features where dampers are fitted on the fan inlet connections (variable air volume) to check the operation of the damper and linkage.

To prevent brinelling of bearing the fan manufacturer's recommendations for maintaining the bearing in good working order shall be followed.



C12.23 AXIAL FLOW FANS

Each fan shall be complete with the following:-

- (a) External lubrication unless the fan is equipped with sealed bearings requiring no repacking.
- (b) Flexible connections complete with flanged securing ring each side of fan.
- (c) Standard detachable feet.
- (d) Mounting plates (vertically installed fan).
- (e) Inspection doors in casing.
- (f) Impeller and motor housed in a galvanised casing with flanged ends.
- (g) Fitted with motor and bearings suitable for the air, vapour or hot gas temperature involved.
- (h) Air flow and direction of rotation arrows.
- (i) Flameproof enclosures shall comply with the requirements of BS EN 50018 for the appropriate gas group.
- (j) Anti-vibration mountings.
- (k) Capable of the specified performance when tested in accordance with BS ISO 14695.

C12.24 P.V.C. AND PROTECTIVELY COATED FANS

P.V.C. and protectively coated fans shall be generally in accordance with the previous clauses for fans.

The protection coating shall cover all parts of the complete fan, motor, casing assembly in contact with the vapour or corrosive gases.

During the installation of fans, care shall be taken to protect the coating of the fan assembly against damage. Site Damage shall be made good to the protective coating suppliers' recommendations.

PVC and Protectively Coated Fans shall be installed in the locations indicated on the drawings, and be as detailed in the Schedule of Technical Requirements contained within Part 'D' of this Specification.

C12.25 BIFURCATED FANS

Bifurcated fans shall be generally in accordance with the previous clauses for fans.

Where hot vapours or gases are being handled the motor and bearings shall be suitable for operating at the temperature they may be subjected to by conduction and radiation from the fan casing.

C12.26 AIR HEATER BATTERIES

Each heater battery shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Angle frames at each end to receive the ductwork connecting flanges, ensuring ease of removal.
- (c) Floor to ceiling supports.



- (d) Secondary heating surfaces bonded to the primary heating surfaces.
- (e) Suitable for the heating medium at the temperature and pressure conditions and duty specified.
- (f) Vertical or horizontal headers with flow and return connections ensuring equal flow of water or steam through all the tubes.
- (g) Provision for expansion, venting and drainage of the header, primary and secondary surfaces.
- (h) Airtight enclosures to headers and pipework connections.
- (i) Gaskets of suitable material between the heater flanges and the ductwork flanges.
- (j) Cleaning and access doors as clause headed Galvanised Ductwork.
- (k) Flanged connections to suit the Specification for the primary heating medium.
- (l) Tested at the manufacturer's works to one and a half times the working pressure and three copies of the test certificates shall be submitted.
- (m) Capable of providing the specified output at the specified design conditions when tested in accordance with BS 5141 : Part 2.
- (n) Provided with a comb to rectify fin damage.
- (o) Have maximum air velocity of 3m/s.
- (p) Unless otherwise specified LTHW/MTHW batteries shall be selected having a maximum water side pressure drop of 20kPa, and the specific pressure drop shall be viewed in terms of achieving a control valve authority of 0.5.

C12.27 ELECTRIC AIR HEATER BATTERIES

Each electric air heater battery shall be as follows:-

- (a) Heating elements enclosed in a rustproof steel flanged casing.
- (b) The elements easily removable for cleaning and replacements.
- (c) Elements arranged in steps to suit the control requirements.
- (d) External terminal box for conduit entry.
- (e) Wiring insulation of appropriate quality to suit the temperature involved.
- (f) High limit cut out.
- (g) Access and cleaning doors as clause headed Galvanised Ductwork.
- (h) Gaskets of suitable material between the heater flanges and the ductwork flanges.

C12.28 COOLING BATTERIES

Each cooler battery shall be as follows:-

- (a) Complete with watertight drip tray, having fall to one end of the tray, and water trapped drain pipe run in copper to the nearest gully.
- (b) Access for cleaning and maintaining base tank and accessories.
- (c) Arranged in a contra-flow pattern, with chilled water entering at leaving air end and leaving at the entering air end.
- (d) Flanged connections to suit the specification for the chilled water/refrigerant.
- (e) Capable of providing the specified output at the specified design conditions when tested in accordance with BS 5141 : Part 1.
- (f) Provided with a comb to rectify fin damage.
- (g) Have maximum air velocity of 2.25m/s.
- (h) Unless otherwise specified cooling batteries shall be selected having a maximum water side pressure drop of 20kPa, and the specific pressure drop shall be viewed in terms of achieving a control valve authority of 0.5.



C12.29 AUTOMATIC ROLL FILTERS

Each automatic roll filter shall be as follows:-

- (a) Complete assembly of filter, frame, motors, rotating spools, drive and filter media.
- (b) Finished to prevent rusting.
- (c) Operate automatically with provision for manual stopping and starting of the filter movement.
- (d) Visual warning lights operated when the filter media is approaching end of roll.
- (e) Timer or pressure differential switch to actuate motor.
- (f) Flanged or suitable duct connections at each side of the filter frame.
- (g) End of roll switch automatically switching off the driving motor.
- (h) Complete with spare roll of filter media.
- (i) Timing interval or operation differential pressure to be marked on the side of the casing.
- (j) The motor and gear box suitable for the temperature of the system when operating under maximum temperature conditions.
- (k) Gaskets of suitable material between filter flanges and the ductwork flanges.
- (l) Edge seals to prevent air by-passing the filter.
- (m) Where filter material is required to be flameproof and the filter is built into ducting, the ducting shall be not less than 1.6mm thick for a distance of 1.8m up and down stream of the filters.

C12.30 DRY REPLACEABLE MEDIA AIR FILTERS

Each dry replacement media air filter shall be as follows:-

- (a) Mild steel holding frame with flanged connections for connecting into the ductwork system.
- (b) Finished to prevent rusting.
- (c) Complete with set of filter units.
- (d) The filter units shall be suitable for front or side withdrawal through an easily accessible air tight access door.
- (e) The filter units housing shall have seals to prevent air leakage around the filter units.
- (f) Gaskets of suitable material between the filter casings and the ductwork flanges.
- (g) Complete with full spare set of filter units.

C12.31 GREASE FILTER OR ELIMINATORS

Each grease filter or eliminator shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association and be,

- (a) Of washable pattern.
- (b) Constructed of metal protected against rusting.
- (c) Fixing frame with the element secured in the frame by easily operated release clips.
- (d) Complete with drip tray.



C12.32 THROW AWAY PATTERN FILTERS

Each throw away pattern filter shall be as follows:-

- (a) Filter media of glass fibre or fabric.
- (b) Finished to prevent rusting.
- (c) Flanged or suitable duct connections at each side of the filter.
- (d) Complete assembly of filter casing and filter media housing.
- (e) Gaskets of suitable material between the filter casing flanges and the ductwork flanges.
- (f) Complete spare set of filters.

C12.33 ABSOLUTE FILTERS

Each absolute filter shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Sealing between cells and protection to the front and rear of the cells.
- (c) Constructed and provided with all necessary equipment to allow a safe change of the filter medium.

C12.34 ELECTROSTATIC FILTERS

Each electrostatic filter shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Automatic wash system with interlocks for reconditioning collecting elements.
- (c) Control panel housing necessary rectifier, transformer equipment, millimetre, interlocks and interconnecting wiring.
- (d) Clear indication of the danger of high voltage.

C12.35 ACTIVATED CARBON TYPE FILTERS

Each activated carbon type filter shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Uniform distributed bed thickness of activated carbon granules.
- (c) Carbon packed to prevent from settling down or forming gaps.
- (d) Thorough sealing between frame and cells and mechanical protection to front and rear of the cells.

C12.36 MANOMETERS

Each air filter (other than grease filters) shall be fitted with a differential pressure gauge to indicate air resistance across the filter and be complete with indicator plate stating clean and dirty conditions.

Each connection to the ductwork shall be carefully positioned and installed to give a true measurement of the static pressure at that point in the duct.



The total length of connecting tube including inlet and outlet for each gauge shall not exceed the manufacturer's recommendations.

Where a filter installation comprises several filters in series (e.g. pre-filter and main filter) a separate manometer shall be fitted for each filter in the installation.

C12.37 AIR HANDLING UNITS

Each air handling unit shall be as follows :-

- (a) Unless otherwise specified, air handling units shall be provided by manufacturers certified as having quality control procedures complying with BS EN ISO 9001.
- (b) The requirements for all individual components of the air handling units (filters, cooling coils, heater batteries, fans, humidifiers) shall comply with the requirements for those components listed elsewhere in this Section of the Specification, together with the requirements stated in the "Air Handling Unit" Clauses.
- (c) All air handling units shall be of double skin construction, with a minimum air gap of 25mm between the inner skin and outer skin. The cavity between the two skins shall be filled with either glass fibre or mineral wool insulation of the same thickness as the cavity, except in specialist cases where the ingress of fibres into the system from the insulation material would create a problem. In the latter case, a non-fibrous insulation material shall be incorporated. The thermal conductivity of the insulation material shall not exceed 0.039W.M deg.C.
- (d) The air handling unit framework shall be of adequate strength and rigidity to suit the particular application and shall be of penta-post or channel construction, as a minimum, except where otherwise specifically stated in this specification. On applications where cooling of the air takes place, the cavity within the framework shall be filled with insulation material.

The air handling unit casing panels shall be of sufficient thickness and be braced to avoid drumming or distortion. The average sound reduction for an air handling unit panel, shall be not less than 40dB (125Hz - 4KHz).

The air handling unit shall be of a rust proof finish and shall incorporate suitable internal corrosion protection. Where the air handling unit casing is of galvanised construction, or is not of a suitable self-finish, the air handling unit shall be painted prior to handover with one coat of a suitable primer and two coats of gloss finish to an approved colour, and in accordance with the "Painting" clause in Part 'B' of this Specification.

- (e) The unit shall have lifting lugs or marked lifting positions and be off-loaded and installed using correct tackle and spreader bars if necessary in accordance with the manufacturer's recommendation, so that distortion and buckling does not occur.

Unless otherwise specified in detail, the air handling unit shall be formed from a number of individual components. A perimeter base frame running the full length of the unit shall be provided (plus a centre support in the appropriate cases). The perimeter base frame shall adequately support the air handling unit components, and the air handling unit components shall be fitted to the base frame so as to ensure a safe and secure fixing.



- (f) The drain pipework from all humidifiers and cooling coils shall be run in copper laid to fall and run to the nearest gully, or as indicated on the drawings, and incorporate U traps of glass construction, having a suitable depth to maintain the water seal with a difference in water level in the trap in excess of the air handling unit fan total pressure. The height of the perimeter base frame shall exceed the height of the U trap, and allow for the fall of the drain pipework over its entire length and air gap at the discharge position. The drain connection shall incorporate a removable plug for recharging the water seal in the U trap, and the final drain discharge shall have an air gap of a minimum of 100mm, between the pipe and gully. All air venting points or drain points shall be brought through the outer skin of the air handling unit.

All coils (e.g. heating, cooling, heat recovery) shall be independently mounted in the air handling unit casing such that they can be removed without the need to remove the casing.

- (g) The fan size and fan curve shall be selected as detailed under the "Selection of Fans" Clause contained in this Section of the Specification, and the fan and motor shall be capable of dealing with an excess pressure development of 15% above the required total pressure at the design volume whilst still being within the normal fan operating range and without causing problems of regenerated noise.

Where the fan section arrangement incorporates externally mounted motors and drives, these shall be complete with guards and a supporting grillage shall be provided as part of the air handling unit, and shall be complete with anti-vibration mountings and supporting base frame.

- (h) Anti-vibration mountings (spring type unless otherwise specified) shall be provided to isolate the fan, drive, motor and supporting base frame from the air handling unit casing. Flexible duct connections shall be provided to isolate the fan section from the remainder of the unit and/or the connecting ductwork.

Airtight access doors, incorporating either the hinged type or quick release twist type fixings shall be incorporated to provide easy access to all working parts. (Screwed or bolted fixings shall not be allowed). Space shall also be provided in the component depth or by access to adjoining components to ensure adequate facilities are available for cleaning and maintaining all items within the unit without having to remove these or remove adjoining components. This shall include coils/batteries of all types, humidifiers/washers of all types, and base tanks of all types.

- (i) Inspection windows and internal lights (pre-wired to a terminal block on the external face of the casing) shall be provided on the fan section of all air handling units incorporating variable air volume facilities.
- (j) In air handling units where humidifiers and/or cooling coils are specified, no carry over of moisture shall be permitted. The manufacturer shall include for the provision of suitable eliminators where necessary, to ensure compliance with this requirement.
- (k) Where automatic dampers are specified and these are described as motoring or moving to the closed position under certain conditions, the dampers provided shall be of an airtight pattern, with suitable sealing gaskets, and the like to ensure minimum leakage not exceeding 3% of design flow rates.

Automatic dampers on mixing box sections shall be interlocked as appropriate to ensure satisfactory operation.



- (l) All motors specified shall have a rated capacity of not less than 15% greater than the maximum absorbed horse power (including all losses in belts and drives, and the like).
- (m) Air handling units shall be positioned in relation to adjoining walls, and the like such that the access space allowed above, below, or at the side of the air handling unit, as appropriate, shall be not less than the dimension of the largest component to be removed for maintenance or repair purposes (i.e. cooling coils/heating coils).
- (n) Air handling units shall be protected against damage during the erection period.
- (o) Manometers, as detailed under the "Manometers" clause in this Section of the Specification shall be installed on filters on all air handling units.
- (p) Air handling unit fan sections shall be capable of the specified performance when tested in accordance with BS 6583 'Volumetric Testing for Rating of Fan Sections in Central Station Air Handling Units'.
- (q) Where air handling units are installed in a ceiling void, they shall be as detailed above but, with a minimum gap of 50mm between the inner and outer skin.
- (r) Air handling unit pressure classification and leakage testing shall be in accordance with the requirements of DW/144 and DW/143.

C12.38 HEAT RECOVERY WHEELS

Heat recovery wheels shall be provided where specified and shall comply with the following requirements :-

- (a) Suitable spigots or flanges shall be provided to facilitate connections for adjoining ductwork or air handling unit sections. Where the wheel forms part of the air handling unit assembly, connections shall be of the same size as the adjoining air handling unit components.
- (b) Access sections of minimum width 450mm, with hinged or similar easily removable panels (not screwed or bolted) shall be provided on the upstream and downstream side of the supply and extract ductwork or air handling unit connections to the heat recovery wheel (i.e. four no. in total).
- (c) The wheel shall be suitable for recovering both latent heat and sensible heat, unless specified otherwise.
- (d) Each latent and sensible unit shall have a drain connection, complete with drain pipework run in copper laid to fall, run to the nearest gully, or as indicated on the drawings, and incorporate U traps of glass construction, having a suitable depth to maintain the water seal with a difference in water level in the trap in excess of the air handling unit fan total pressure. The height of the perimeter base frame shall exceed the height of the U trap, and allow for the fall of the drain pipework over its entire length and air gap at the discharge position. The drain connection shall incorporate a removable plug for recharging the water seal in the U trap, and the final drain discharge shall have an air gap of a minimum of 100mm, between the pipe and gully. All air venting points or drain points shall be brought through the outer skin of the air handling unit.



- (e) The wheel rotor shall be of a fire proof corrosion resistant, rot-proof, vermin proof material which is non-injurious to health and shall be suitable for the system in use without deterioration of the rotor. The condition of the air passing through the wheel shall be established by the manufacturer to ensure compliance with the above requirements.
- (f) The wheel shall incorporate an adjustable purge section for self-cleaning purposes and, where necessary, due to the condition of the supply and/or the exhaust air, a filter shall be provided on the supply and/or exhaust air ductwork to the wheel prior to the air passing through the wheel. The need or otherwise for filters shall be defined by the wheel manufacturer.
- (g) The wheel shall be provided with all necessary controls to facilitate its correct operation as a heat recovery device during winter on ventilation and air conditioning systems and during summer on air conditioning or comfort cooling systems. These controls shall include the following :-
 - * Time switch interlocks and an interlock with the extract fan to ensure the wheel only works when the system is in operation.
 - * A contactor/starter with overload protection on the electrical power supply to the heat wheel motor.
 - * A thermistor type protection device in the heat wheel motor.
 - * Sensors and control units to ensure variable speed operation of the wheel to effect the required amount of heat recovery in winter and operation of the wheel in summer on air conditioning systems when the outside enthalpy exceeds the enthalpy of the exhaust air.
- (h) The manufacturer shall clearly indicate any requirement for screened cables on heat wheel controls.
- (i) The rotor material shall not contain asbestos. The structure shall be of the channel type with laminar flow through the rotor.
- (j) Unless specified otherwise, each heat recovery wheel shall be supplied with mounting feet and lifting lugs, together with a suitable drain point. Grease points, where provided, shall be extended through the casing and a suitable size access panel installed to ensure that proper and efficient access can be achieved to the motor and drive mechanism.
- (k) Clearance between the rotor and the heat recovery wheel casing shall be efficiently sealed to prevent leakage between the supply air and exhaust air ducts.
- (l) The manufacturer, control specialist and sub-contractor shall liaise to ensure that the correct wheel components and controls are provided to ensure the correct operation of the wheel in accordance with the design intent. Commissioning of the wheel and associated controls shall be carried out by the manufacturer and Controls Specialist, and full details of all tests shall be incorporated in the Operating & Maintenance Manual.



C12.39 CROSS FLOW PLATE HEAT EXCHANGERS

Each cross flow plate heat exchanger or recuperator, shall comply with the following requirements :-

- (a) Have suitable spigots or flanges to facilitate connection for adjoining ductwork or air handling unit sections.
- (b) Have air tight, minimum 450mm wide hinged or similar easily removable access panels (not screwed or bolted) on the upstream and downstream side of both the supply and extract ductwork or air handling unit connections (i.e. four no. in total).
- (c) Have a pre-filter, as described elsewhere in this specification, fitted in the supply air ductwork prior to the heat exchanger, to minimise fouling of the plates.
- (d) Be suitable for recovering both latent and sensible heat, unless specified otherwise.
- (e) Each latent and sensible unit shall have a drain connection, complete with drain pipework run in copper laid to fall, run to the nearest gully, or as indicated on the drawings, and incorporate U traps of glass construction, having a suitable depth to maintain the water seal with a difference in water level in the trap in excess of the air handling unit fan total pressure. The height of the perimeter base frame shall exceed the height of the U trap, and allow for the fall of the drain pipework over its entire length and air gap at the discharge position.

The drain connection shall incorporate a removable plug for recharging the water seal in the U trap, and the final drain discharge shall have an air gap of a minimum of 100mm, between the pipe and gully. All air venting points or drain points shall be brought through the outer skin of the air handling unit.

- (f) Where connected to a system serving a kitchen area, each heat recovery unit shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association.

C12.40 INDUCTION UNITS

Each induction unit shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Primary air plenums with regulating devices and easily removable and replaceable air nozzle assemblies to produce quiet operation.
- (c) Adjustable fixing brackets.
- (d) Protection during erection period.
- (e) Ready access to all working parts.
- (f) Air outlet incorporating a means of directional control of the air supply.
- (g) Heating/cooling coils with air cock.
- (h) Duct and cover to appropriate end of unit, where units are not connected at both ends.
- (i) Drain pans.



C12.41 FAN COIL UNITS

Each fan coil unit shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Adjustable fixing brackets.
- (c) Protection during erection period.
- (d) Ready access to working parts.
- (e) Heating/cooling coil with air cock.
- (f) Drain/drip tray extended below control and isolating valves.
- (g) Easily removable air filter.
- (h) Motor windings shall be protected to avoid trouble from condensation.
- (i) Inlet and directional outlet grilles.
- (j) Thermal/Acoustic lining and anti-vibration mountings.
- (k) Capable of the scheduled thermal and volumetric performance as determined in accordance with BS 4856 : Part 2 or Part 3 as appropriate.
- (l) Complete with integral condensate lift pump, having a minimum head of 3m.

C12.42 HIGH VELOCITY SINGLE AND DUAL DUCT TERMINAL UNITS

Each terminal unit shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Fixing brackets.
- (c) Protection during erection period.
- (d) Ready access to working parts.
- (e) Acoustic lining.
- (f) Volume control device.
- (g) Dual duct units shall ensure thorough mixing of all discharge.
- (h) Heating and cooling coils.

C12.43 VENTILATED CEILINGS

The ventilated ceilings shall be as follows:-

- (a) Installed in accordance with the manufacturer's recommendations.
- (b) Complete with support systems designed to carry the weight and forces of the ventilated ceiling system.
- (c) Have removable tiles.
- (d) Have formed openings for light fittings and grilles.
- (e) Be complete with acoustic insulation.
- (f) Where installed in kitchens, comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association.

Before commissioning the ceiling void shall be satisfactorily free of dust and be airtight.



C12.44 ACOUSTIC DOORS

Each acoustic door shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Airtight insulated door panel.
- (c) Angle frame with building in cleats.
- (d) Locking handles suitable for operating from both sides.
- (e) Cylinder lock operable from inside without a key.

C12.45 PLASTIC DUCTWORK

The construction of the plastic ductwork shall be in accordance with the specification published by the Heating and Ventilating Contractors Association DW/154, except for the material utilised for plastic ductwork buried underground. Plastic ductwork shall be to BS 5481 and installed in accordance with the manufacturers instructions.

All plastic ductwork shall be suitable for the pressures, temperatures, gases and vapours for the system and generally as detailed in 'Flexible Connections'.

All plastic ductwork shall be manufactured and installed by one of the firms specialising in this particular trade.

C12.46 GLASS FIBRE DUCTWORK

The construction of resin bonded glass fibre ducting shall be in accordance with the Specification published by the Heating and Ventilating Contractors Association DW/191.

The internal surfaces shall be specially smooth to prevent erosion of the internal surfaces. Where required the stiffening provision shall be continuous around the duct to prevent deflection of the ductwork.

C12.47 STEAM HUMIDIFIERS

Each steam humidifier shall be as follows:-

- (a) Modulating air or electric motor operator.
- (b) Stainless steel steam jacketed distribution manifold to ensure uniform distribution of dry vapour.
- (c) Separator.
- (d) Temperature switch to prevent humidifier coming on when not entirely warmed up.
- (e) 'Y' type strainer.
- (f) Inverted bucket trap.

The steam humidifier shall be installed to the manufacturer's recommendations including the recommended distances away from fans, coils, filters, change sections and temperature controller.



C12.48 SPRAY COIL HUMIDIFIER

Each spray coil humidifier shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Coil generally as per section headed 'Cooling Batteries'.
- (c) Tank forming the base of the spray unit coil and eliminator section.
- (d) Access door with glazed inspection port and watertight exterior light fitting.
- (e) Spray headers, nozzles, motor driven pump, anti-vibration mountings, strainer, pressure gauge and galvanised distribution pipework.
- (f) Water makeup connections to ball valve.
- (g) Combined overflow and trapped drain connection to nearest gully.
- (h) Easy access to maintain all working parts and for cleaning removable nozzles.

C12.49 CAPILLARY TYPE AIR WASHER

Each capillary type air washer shall be as follows:-

- (a) Finished to prevent rusting.
- (b) Cell material of glass nylon or other approved fibres orientated parallel to the direction of air flow.
- (c) Access door with glazed inspection port and watertight light fitting.
- (d) Tank shall form the base for the cell mounting frame.
- (e) Combined overflow and trapped drain to nearest gully.
- (f) Spray headers, nozzles, motor driven pump and vibration mountings, strainer, pressure gauge and galvanised distribution pipework.
- (g) Water makeup connection to ball valve.
- (h) Easy access to maintain all working parts and for cleaning removable nozzles.
- (i) Complete with spare cells.

C12.50 PRESSURE RELIEF FLAPS

Each pressure relief flap shall be as follows:-

- (a) Arranged to pivot open and closed.

C12.51 TRANSFER GRILLES

Each transfer grille shall be as follows:-

- (a) Consist of two grilles i.e. front and rear.
- (b) Of satin finished aluminium.
- (c) Provided with a foam plastic gasket to prevent staining of the wall and ceilings.
- (d) Fixed into wood frames with aluminium screws or suitable plated wood screws.
- (e) Be of the non-vision type.
- (f) Be of the quick release type.
- (g) Where installed in compartment or sub-compartment walls, be fitted with a electro mechanical, mechanical or intumescent fire damper, all as agreed with the Services Engineer.



C12.52 REFRIGERANT PIPEWORK

Pipe work shall be refrigerant quality copper, fully annealed and internally degreased and cleaned. All refrigerant piping shall be seamless, round copper tube to BS EN 12449 or BS EN 12450. All joints shall be braised with high temperature solder using oxygen free nitrogen. Manipulative compression (flared) joints shall not be used in pipelines except in the form of flared couplings for connection to equipment. The refrigerant piping shall be pressure tested to establish that it is completely leak proof, then thoroughly evacuated (triple evacuation) to remove all moisture, oxygen (air) plus any other condensable product. A strength test in accordance with BS EN378 shall be carried out.

In all cases refrigeration works shall be carried out in accordance with BS 4434 (Safety and Environmental Aspects in the Design, Construction and Installation of Refrigerating Appliances and Systems), the Institute of Refrigeration Safety Codes and HSE Guidance Note PM81

The use of bending machines on pipework over 42mm shall not be permitted.

Where exposed the pipework shall be supported with polished cast gunmetal built in clips.

Pipework installed in service ducts, ceiling voids, or together with other service pipework shall be supported by gunmetal munzen rings from the common angle or channel iron supports.

All pipes shall be supported at not more than the following intervals:-

<u>Size of Pipe (mm)</u>	<u>Interval for Supports (mm)</u>
15	1200
22	1200
28	1500
35	1500
42	2000
54	2000
67	2000
76	2000
108	2400
135	2700
159	2700

Support to all pipe work and controls cabling throughout their length shall be using galvanised cable tray, firmly fixed to the building fabric, using factory made fittings throughout of same material type at centres of 1-1.5 meters, pattern, finish and thickness as tray. Where pipes pass through walls, floors, and the like, sleeve pipes and floor plates shall be provided. Where prone to mechanical damage running at low level, inverted cable tray shall also be affixed over the pipework with suitable spacers (so as not to compress/dislodge the thermal insulation).

All exposed pipe runs shall be arranged to present a neat appearance, parallel with other pipe or service runs and the building structure. All vertical pipes shall be plumb or follow the building line. Pipe runs shall be spaced in relation to one another, other services runs and the building structure. The Contractor shall allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc. Precautions shall be taken to prevent the discharge of refrigerant gases to atmosphere.



The refrigerant piping shall be insulated along its entire length for thermal insulation and to avoid contact between copper and galvanising of support tray all as detailed in section C13.

External to building Armaflex Tuffcoat shall be installed to protect insulation from mechanical impact, rodent attack and bird attack. Fittings and valves shall be wrapped with same insulation as pipe work.

C12.53 REFRIGERANT SELECTION

Where the provision of chiller/compressor plant forms part of the works, the required refrigerant type shall generally be indicated within Part D of this specification. However, if refrigerant selection is left to the Contractor then only ozone benign (minimal Ozone Depletion Potential & Global Warming Potential) products are to be used, in accordance with currently published and accepted good practice, the Montreal Protocol, and other such subsequent international agreements which the UK government signs up to.

CFC based refrigerants shall not be used in any circumstances (new installation or maintenance). HCFC's are only to be used with the Engineer's consent. Attention is drawn to EU Regulation 2037/2000 which relates specifically to ozone depleting substances and mandatory banning of CFC and HCFC usage, namely:

- CFC's shall not be used for the servicing of existing installations after the end of 2000
- HCFC's shall not be used in most applications after 2001 (some exceptions until 2004)
- HCFC's shall not be used for servicing existing systems from 2010
- Total ban on HCFC's from 2015

HFC's are to be regarded as first choice selection, but they are covered by the Kyoto Protocol and as such are not regarded as a long term solution.

Ammonia and Hydro-Carbon based refrigerants shall only be used with the express permission of the Engineer. In such cases all necessary safety measures and secondary systems are to be provided.

Refrigerant selection, particularly in a retrofit situation must be compatible with the refrigeration equipment in order to achieve safe and stable operation, together with the required cooling performance.

In all cases refrigeration works shall be carried out in accordance with BS 4434 (Safety and Environmental Aspects in the Design, Construction and Installation of Refrigerating Appliances and Systems), the Institute of Refrigeration Safety Codes and HSE Guidance Note PM81.

C12.54 SMOKE VENTILATION

Smoke control ventilation systems shall be designed and installed in accordance with BS EN 12101-6. Approval for the design of the system shall be obtained from the Local Building Control Authority before installations commence. All fans associated with emergency fume and smoke ventilation shall bear the CE mark.



C12.55 PRESSURISED SYSTEMS FOR SMOKE CONTROL

Ventilation ductwork systems used to provide air for smoke control purposes shall be of sheet metal construction and installed to the requirements of DW/144 unless noted otherwise.

C12.56 FIRE RESISTING DUCTWORK

Ductwork systems shall be manufactured and installed in accordance with BS EN 12101-6 and shall be capable of providing the required fire containment specified to suit the location to which it is installed.

Under normal non-fire operating conditions the ductwork shall conform to the required pressure classifications defined in DW/144.

The ductwork shall give the specified stability, integrity and insulation when tested in accordance with BS 476 : Part 24 : 1987.

C12.57 IMPULSE FANS – CAR PARK VENTILATION

Car park ventilation systems shall be installed to the full approval of the Local Statutory Authority.

Systems shall be sized to provide 6 No. air changes per hour for exhaust fume extract and 10 No. air changes per hour for smoke clearance, as recommended in Approved Documents, Parts B and F.

Fans shall be rated to run at 300°C for a minimum of 60 minutes. All fans associated with emergency fume and smoke ventilation shall bear the CE mark.



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PART C - SECTION 13 THERMAL AND ACOUSTIC INSULATION

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THERMAL AND ACOUSTIC INSULATION

The following British Standards Specifications and Codes of Practice are relevant to this Section :-

BS 476	Fire Tests on Building Materials and Structures.
BS 5111	Method of test for determination of smoke generation characteristics of cellular plastics and cellular rubber materials.

The Building Regulations Approved Document B, Appendix A, Definition of Class O Fire Rating.

BS 874	Methods of determining thermal properties with definitions of thermal insulating terms.
BS 1710	Identification of pipelines.
BS 3533	Glossary of terms relating to thermal insulation.

TIMSA guidance for achieving compliance with Part L of the Building Regulations (March 2006) & Scottish Building Regulations (Section 6)

BS 5422	Method for specifying thermal insulation on pipes, ductwork and equipment in the temperature range -40°C to +700°C. Where applicable for Enhanced Capital Allowances, insulation thickness shall be in accordance with “Environmental Thickness Tables” as specified by the DETR.
BS 3958	Thermal insulating materials.
BS EN 13166	Phenolic Foam (PF) for thermal insulation in the form of slabs and profiled sections.
BS 4508	Thermally insulated underground piping systems.
BS 6700	Water services for domestic use.
BS EN 12828 & 12831)
BS 6880) Central heating by low pressure hot water
)
CP 342	Code of Practice for Centralised hot water supply.
BS 5970	Code of Practice for thermal insulation of pipework and equipment in the temperature range of -100°C to + 870°C.
BS 7572	Code of Practice for Thermally insulated underground piping system.



C13.2 THERMAL INSULATION

The installation of all pipework, ducting and other plant and equipment shall ensure that sufficient spacing is provided to allow for the specified thickness of insulation to be applied with a minimum clearance of 50mm between adjacent insulated surfaces or other adjacent structures.

Insulating materials and finishes shall be completely free of asbestos. Work on existing insulation which contains asbestos shall be carried out with all precautions in accordance with the Asbestos Regulations 1969 or the Health and Safety at Work Act 1974 and the Health and Safety Executive Guidance Notes.

Insulation materials in occupied areas should have a Euroclass of either A1, A2, B or C, should have a FIGRA RCT of less than 1.0 and should not have a potential to flashover.

All thermal insulating materials shall have a Class 'O' Fire Rating in accordance with the Building Regulations, Approved Document B (Fire Safety), Appendix A, Clause A12 when tested to BS 476 : Part 4 or BS 476 : Parts 6 and 7.

All finishes shall comply with BS 476 : Part 7, Class 1 Spread of Flame.

The completed installation shall comply with BS 476 : Part 7, Class 1 Spread of Flame and Class 'O' Surface Rating of Building Regulations.

Where applicable, complete fire rated ductwork installations (including the support system) shall be fully compliant with the methodology and requirements of BS 476 : Part 24, that is in relation to "Stability", "Integrity" and "Insulation."

All insulation materials, including adhesives, sealants and facings installed within buildings and building services ducts shall not produce large volumes of smoke or toxic fumes when involved in a fire. Thermal insulating materials shall have a smoke obscuration rating not exceeding 5% in accordance with BS 5111.

Insulating materials that contain and/or require the use of CFCs and HCFCs in their manufacture shall not be used.

All insulation materials and finishes shall be inherently proof against rotting, mould and fungal growth and attack by vermin, be non-hygroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment in which they are installed.

All materials delivered to site shall be new and fully dried out and so maintained throughout the progress of the works. The only exceptions shall be those materials which are applied wet, subject to the material not depending on an initial dry state before application.

No polystyrene material shall be used for thermal or acoustic insulation purposes within buildings.

Existing insulation disturbed or damaged during the progress of the work shall be made good.

All pipework and ductwork systems shall have been successfully pressure tested, inspected and accepted and, where applicable, warmed to a temperature not less than the dewpoint temperature of the ambient air and so maintained before any thermal insulation is applied. Insulation shall not be applied to surfaces covered with frost or condensation.



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To ensure that the correct thickness and specification of insulation has been applied, one section of each type of insulation shall be cut out for inspection. If the insulation reveals defects, a further two sections shall be cut out for inspection. If these prove defective the whole of the insulation shall be removed and new insulation and finishes, as specified, applied at no additional cost.

Particular attention shall be given to the finished appearance of all thermal insulation which must present a neat and symmetrical appearance running true in line with pipe layouts.

Any rough, irregular or badly finished insulation at surfaces, bends, tees and supports shall be stripped down and re-insulated.

Where applicable, allowance for expansion and contraction of insulation shall be made by means of 6mm gaps at intervals as specified in BS 5970.

All longitudinal and circumferential joints shall be suitably taped with 75mm wide self adhesive tape to match the finish to which it is being applied.

Where instrument points, tappings, name plates, plant instructions and the like are provided in the installation, the insulation shall be cut away and the edges neatly finished and sealed.

Pipework or ductwork shall be insulated separately and adjacent parallel pipes shall not be married together in one common insulation covering.

The mixing of type or manufacturer of insulation shall not be permitted unless otherwise detailed in this section of the specification.

Insulation shall be neatly squared off at all insulated or uninsulated obstructions in pipework and ductwork allowing for expansion, contraction, easy access and disconnection of removable items without the disturbance of the surrounding insulation. All squared off ends shall be covered with purpose made end caps, where possible matching the insulation outer covering.

Insulation on all cold services pipework, ductwork, vessels and equipment shall be provided with a fully sealed continuous vapour barrier in accordance with BS 5422 : 2001, Clauses 5.7 and 6.2.3.

All insulation installed external to buildings shall be provided with a fully sealed weatherproof finish. Where exposed to mechanical damage a weatherproof finish with appropriate resistance to such damage shall be installed.

Components such as bolted ends, manholes, access doors, removable chests on vessels, valve bodies, flanges, pipe guides, anchor points and expansion bellows shall be insulated.

All insulating materials shall be installed in accordance with the manufacturers recommendations and be of uniform thickness. No insulation having damaged ends or edges shall be used.

Where insulation is applied to ductwork having a dimension exceeding 500mm width or depth, self adhesive insulation pins and speedfix washers shall be attached at 300mm centres to the ductwork to allow the insulation complete with adhesive to be impaled on the pins. Care shall be taken to ensure that the integrity of the vapour seal is maintained by removing excess length of pin and covering the washers with strips of matching self-adhesive foil tape.



In accordance with BS5970: 2001.

Before applying any type of insulating material, all types of surface which are to be insulated shall be dry clean and free of all foreign matter. In order to reduce the risk of pinhole corrosion of copper surfaces particular care shall be taken to ensure the removal of all corrosive building debris dust and surplus soldering flux and the following procedures shall be followed.

1. Completely wipe clean the surface of the copper to remove all traces of moisture, dust and grease, surplus flux and any other building debris.
2. Proceed to fit the insulating material in the normal manner.
3. Joint sealing overlaps provided on the aluminium foil facing of any type of insulating material shall not be tucked inside the joint where they may make contact with the copper surface and initiate bi-metallic corrosion.

C13.3 TRACE HEATING

Where electric trace heating is fitted to pipework oversized pre-formed sections of insulation shall be provided to accommodate the thickness of the trace heating cable.

C13.4 PAINTING

All insulation shall be painted with two coats of good quality heat resistant Class 'O' Fire Resistant coating applied in accordance with the manufacturer's instructions, except where concealed, protected by metal casings, weatherproofing, P.V.C. or self-coloured finishes. Absorbent surfaces shall be given an initial coat of priming paint. The basic colour of the coating shall be approved before application. Final identification bands shall be in accordance with BS 1710, where applicable.

C13.5 PROTECTION OF ADJACENT PLANT, MACHINERY & BUILDING SURFACES

All new and existing pipework, machinery, plant and building surfaces shall be protected throughout the progress of the insulation contract.

C13.6 THICKNESS AND FINISHES TO INSULATION

The thickness of insulation, specification and finishes shall be determined in accordance with the thickness tables scheduled at the end of this section of the specification.

C13.7 IDENTIFICATION OF INSULATED SURFACES

All pipework insulation shall be identified in accordance with the Pipework and Identification section of this part of the specification. Ductwork insulation shall be painted as specified under the "Painting" clause with contents and direction of flow stencilled on.

C13.8 ACOUSTIC INSULATION

Sound absorbent materials shall be inert, non-hygroscopic and vermin proof with all joints overlapped and shall have a Class 'O' Fire Rating when tested to BS 476 : Part 4.



The material shall be securely attached to the surface to which it is applied, in full accordance with manufacturer's instructions.

Where acoustic insulation is applied to an external surface of ducts or equipment etc., the finishes that require painting shall be completed as clause headed 'Painting' and 'Identification of Insulated Surfaces'.

C13.9 PIPEWORK AND DUCTWORK SUPPORTS

All insulated pipework and ductwork installations shall be supported by load bearing insulation support unit inserts installed between the insulated surface and the support member.

On services with operating temperatures up to 85°C high density load bearing phenolic foam spacing pieces shall be used.

For services operating at temperatures above 85°C, the load bearing material shall be:

Calcium silicate having a density of 210kg/m³.

Or:

Hard wood blocks.

Each load bearing spacing piece shall be the same thickness as the adjacent insulation and be protected by a galvanised sleeve with a minimum thickness of 1mm and width of 100mm. The width and location shall be adjusted, as necessary, to suit expansion.

All load bearing inserts shall be purpose-made products and installed strictly in accordance with the manufacturer's instructions.

C13.10 MINERAL WOOL

All mineral wool shall be water repellent and non-hygroscopic and comply with BS 3958.

Part 3 : Man-made mineral fibre mattresses.

Part 4 : Bonded pre-formed man-made mineral fibre pipe sections.

Part 5 : Bonded man-made mineral fibre slabs.

Pre-formed rigid pipe sections, slabs and flexible blanket shall be supplied complete with a fully adhered factory applied facing of Bright Class 'O' glass scrim reinforced aluminium foil and having a water vapour permeance of 0.001 g/s(MN). They shall be Class 'O' Fire Rated and have a thermal conductivity not exceeding 0.032 W/m.K at 10°C mean temperature.

For all mineral wool insulation products test evidence must be available showing that the fibres from which the products are made are not classified as a possible human carcinogen, as detailed by European Directive 97/69/EC. No link between exposure to mineral wool fibres and lung disease in production or user industries. IARC Group 3 (Not classifiable). Approved Supply List of CHIP98.

Being a COSHH listed material, care shall be taken in the handling and installation of mineral wool. Insulation materials should have the relevant certification, undertaken in line with the required EU method, indicating that fibres are not classified under CHIP 98 Regulations and EU Directive 97/69/EC.



For pipe sections mineral wool material shall have a minimum nominal density of 75 kg/m³.

For flexible and rigid ductwork insulation, mineral wool material shall have a minimum nominal density of 24 kg/m³ and 32 kg/m³ respectively.

C13.11 PHENOLIC FOAM

Phenolic foam shall be Zero ODP closed cell, CFC and HCFC free and comply with BS EN 13166 Rigid phenolic foam (PF) for thermal insulation in the form of slabs and profiled sections.

Pre-formed sections, slabs and laminate shall have a Class 'O' Fire Rating and thermal conductivity not exceeding 0.021 W/m.K (aged value) at 10°C mean temperature unassisted by facing materials.

All phenolic foam products shall be supplied complete with fully adhered factory applied facing of Bright Class 'O' glass scrim reinforced aluminium foil and having a water vapour permeance of 0.001 g/s(MN).

All phenolic foam insulation applied to pipework shall be pre-treated with the manufacturers factory applied passivating and dust suppressent bore coating.

All phenolic foam insulation applied to ductwork shall be bonded to the surface with suitable adhesive.

C13.12 VAPOUR BARRIERS

Vapour barriers incorporated in insulation shall, where possible, be continuous. Where this is not possible, the vapour barrier shall be returned effectively and sealed to the pipe, duct or vessel surface using a suitable mastic vapour sealant.

The removable portions of the insulation to access doors, flanged joints, manholes, valves, binder points, and the like shall be fitted as separate items with their vapour barrier overlapping and sealed to the main vapour barrier.

All vapour barriers shall be applied such that it provides a continuous protection against the penetration of water vapour over the whole surface of the insulation it covers. The permanence values of the vapour barrier shall not be exceed the requirements in BS 5422 : 2001, Clauses 10.3 and 14.3. (BS 5422 : 2001, Clauses 4.7 and 6.2.3).

External weatherproof insulation shall be continuous and shall not be punctured by supports, special care being paid to sealing of the insulation at access doors, manholes, valves, flanges, expansion joints and anchor points to prevent ingress of water. External jacketing shall be perforated with 6mm diameter drain holes at 150mm centres on the underside. Drain holes shall not perforate the underlying insulation vapour barrier on cold insulation systems.

Care shall be taken not to puncture the vapour barrier where screws or rivets are used to secure a final cladding. The cladding should preferably be secured by banding wherever possible.

Note : Reference BS 5422 : 2001, Clause 25.1.8 – “The vapour barrier should not be used as the final surface finish if it is likely to be easily damaged.”



C13.13 SITE STORAGE

All forms of insulation shall be kept dry and packing used for transport of insulating material shall provide protection against inclement weather conditions. Accommodation shall be provided under this section of the works to store insulating materials in a dry atmosphere and under cover.

C13.14 ALUMINIUM SHEETING

Aluminium cladding installation and thickness shall be in accordance with BS 5970 : 2001, Sections 27, 28 and Table 7. Cladding shall be formed to fit tightly over the outer circumference of the insulation with a longitudinal overlap of not less than 50mm. The outer part of the overlap shall be secured with appropriate fixings.

At suitable intervals, provision shall be made to accommodate expansion and contraction.

External joints shall be lapped 'weather wise' in order to shed water and sealed with a suitable flexible sealant.

Screws, rivets and banding used for fixing shall be either aluminium or stainless steel only.

C13.15 PVC CLADDING

Where indicated the insulation shall be finally covered with Isogenopak cladding system and be as follows :

Pipework :

PVC cladding finish shall be 0.35mm thick with longitudinal and circumferential joints lapped by a minimum of 40mm.

Where services incorporate a vapour seal, the joints to the pvc cladding shall have joints secured with Isogenopak solvent adhesive or self adhesive tape.

Services not requiring a vapour seal shall have joints secured with pvc plastic rivets at centres, as recommended by the cladding manufacturer.

Where expansion and contraction is accommodated, straight lengths of sheeting shall not be secured to bends and the like. Where a vapour seal is not required, insulation ends shall be finished with polished aluminium end caps secured to the pvc with aluminium pop rivets.

Ductwork :

PVC cladding finish shall be 0.5mm rigid PVC sheeting and shall be rolls on circular ductwork and flat sheets on rectangular ductwork.

All longitudinal and circumferential joints shall be lapped by a minimum of 40mm.



Ductwork requiring a vapour seal shall be secured with pvc rivets at minimum 150mm centres. Bends shall be covered with preformed Isogenopak bends or, if outside the size range, be carefully mitred from the roll with all joints covered with 30mm matching self adhesive pvc tape.

Cladding of rectangular ductwork shall be secured with a suitable adhesive applied to the whole surface area of the insulation and in accordance with the manufacturer's recommendations. At bends and transformation pieces the pvc shall be feathered to follow the contours of the surface and all corners shall be covered in matching pvc corner angle secured with solvent adhesive, as recommended by the cladding manufacturer.

C13.16 INSULATION SPECIFICATION

SERVICE	LOCATION			SPECIFICATION
PIPED SERVICES				
M & HTHW, Steam and Condensate	Internal		Plant Rooms and exposed below 2.5m	13.MW.1
			Exposed in rooms above 2.5m	13.MW.2
			Concealed	13.MW.2
M & HTHW, Steam and Condensate	External	and External	Ducts	13.MW.3
LTHW & DHWS	Internal		Plant Rooms and exposed below 2.5m	13.PF.3 13.MW.1
			Exposed in rooms above 2.5m	13.PF.1 13.MW.2
			Concealed	13.PF.1 13.MW.2
LTHW & DHWS	External	and External	Ducts	13.PF.4 13.MW.3



Chilled Water	Internal	Plant Rooms and exposed below 2.5m	13.PF.3
		Exposed in rooms above 2.5m	13.PF.1
		Concealed	13.PF.1
Chilled Water	External and Ducts External		13.PF.4
LTHW Pipework and Valve Arrangement to Fan Coil Units including Flexible Connections	Internal	Concealed	13.EF.03
Chilled Water Pipework and Valve Arrangement to Fan Coil Units including Flexible Connections	Internal	Concealed	13.EF.02
First 1.5m of Condensate Pipework from Fan Coil Units	Internal	Concealed	13.EF.01
Refrigeration Pipework	Internal	Plant Rooms	13.EF.04
		Concealed	13.EF.04
Refrigeration Pipework	External		13.EF.04



Oil	External and External	Ducts	13.PF.4
Oil	Internal	Plant Rooms and exposed below 2.5m	13.PF.3
		Exposed in rooms above 2.5m	13.PF.1
		Concealed	13.PF.1
		Plant Rooms and exposed below 2.5m	13.PF.3
Cold Feeds & Open Vents in unheated areas	Internal	Exposed in rooms above 1.5m	13.PF1
		Concealed	13.PF.1
Cold Water Open Vents and Cooling Water	External		13.PF.4
The First 1m of Open Vents		Plant Rooms	13.PF.3
Cold Water	Internal	Plant Rooms and exposed below 2.5m	13.PF.3
		Exposed in rooms above 2.5m	13.PF.1
		Concealed	13.PF.1
Oil Storage Tanks, Hot Wells, Calorifiers & Condense Receivers	Internal		13.MW.5
	External		13.MW.5



Valves & Flanges on M&HTHW, Steam and Condense	External		13.MW.4
	Internal	Plant Rooms	13.MW.4
		Exposed in rooms	13.MW.4
		Concealed	13.MW.4
Anchor Points, Expansion Bellows M&HTHW, Steam and Condense	External		13.MW.4
	Internal	Concealed	13.MW.4
	External		13.PF.7
Valves & Flanges on LTHW, DHWS & Cold Water Services	Internal	Plant rooms and exposed below 2.5m	13.PF.6 13.MW.4
		Exposed in rooms above 2.5m	13.PF.5
		Concealed	13.PF.5
All Valves & Flanges on Chilled Services	External		13.PF.7
	Internal	Plant Rooms and exposed below 2.5m	13.PF.6
		Exposed in rooms below 2.5m	13.PF.5
		Concealed	13.PF.5
Cold Water Tanks			Shall be supplied pre-insulated
Pumps (Hot Surface) M&HTHW	Internal		13.MW.4



Pumps (Cold Surface) Chilled Water	Internal		13.PF.6
AIR SYSTEMS			
Plenum & Hot Air Supply Ductwork	Internal	Plant rooms and exposed below 2.5m	13.PF.9 (R) 13.PF.11 (C)
		Exposed in rooms above 2.5m	13.PF.8 (R) 13.MW.6 (C)
		Concealed	13.PF.8 (R) 13.MW.6 (C)
Plenum Hot Air Supply And Air Conditioning Ductwork	External		13.PF.10 (R) 13.MW.7 (C)
Fresh Air Intake Ductwork	Internal	Plant rooms and exposed below 2.5m	13.PF.9 (R) 13.PF.11 (C)
		Exposed in rooms above 2.5m	13.PF.8 (R) 13.M.W. 6 (C)
		Concealed	13.PF.8 (R) 13.MW.6 (C)
	External		13.PF.10 (R) 13.MW.7 (C)
Air Conditioning Supply Ductwork	Internal	Plant Rooms and exposed below 2.5m	13.PF.9 (R) 13.PF.11 (C) 13.MW.7
		Exposed in rooms above 2.5m	13.PF.8 (R) 13.PF.6 (C) 13.MW.6
		Concealed	13.PF.8 (R) 13.PF.6 (C) 13.MW.6
	External		13.PF.10 (R) 13.MW.7 (C)



Extract Ductwork Containing air at Sub-ambient temperature	Internal	Plant Rooms and exposed below 2.5m	13.PF.9 (R) 13.PF.11 (C) 13.MW.6
		Exposed in rooms above 2.5m	13.PF.8 (R) 13.MW.6 (C)
		Concealed	13.PF.8 (R) 13.MW.6 (C)
	External		13.PF.10 (R) 13.MW.7 (C)
Boiler Flue Ductwork	Internal		13.CS.1
	External		13.CS.1
Fans (Hot Surface)	Internal		13.CS.1
	External		13.CS.1
Fans (Cold Surface)	Internal		13.PF.9
	External		13.PF.10

- PF - Phenolic Foam (HCFC & CFC FREE, ZERO ODP)
- MW - Mineral Wool (Water Repellent and Non-Hygroscopic)
- EF - Elastomeric Foam
- CS - Calcium Silicate
- R - Rectangular
- C - Circular or Oval

PHENOLIC FOAM

Specification 13.PF.1

Pipework shall be insulated with Zero ODP, bore coated, Foil Faced Phenolic Foam, preformed sections.



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All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide self-adhesive foil tape in order to provide a permanent and continuous vapour barrier over the insulation. Each 1 metre section of insulation shall be firmly secured by two additional circumferential bands of 75mm wide self-adhesive foil tape at 350mm centres and equally spaced between the sealed joints.

Specification 13.PF.2

Note:- This is an alternative specification to be used where a decorative finish is required. It provides a decorative protective finish over the foil. and is a cheaper alternative in plantrooms etc., where the metal finish of 13.PF.3 cannot be afforded.

Pipework shall be insulated with Zero ODP Foil Faced Phenolic Foam, preformed sections.

The insulation shall be covered with a 170 g/m² canvas factory applied membrane. All joints in the canvas shall be overlapped by 50mm and adhered with PVA mastic/adhesive. The canvas covering shall then be wholly sealed with 2 coats of PVA mastic/adhesive.

Where specified by the Services Engineer the insulation shall finally be painted with 2 coats of an acrylic emulsion paint to an approved colour.

Specification 13.PF.3

Pipework shall be insulated with Zero ODP Foil Faced Phenolic Foam preformed sections.

All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide self-adhesive foil tape in order to provide a permanent and continuous vapour barrier over the insulation. Each 1 metre section of insulation shall be firmly secured by two additional circumferential bands of 75mm wide self-adhesive foil tape at 350mm centres and equally spaced between the sealed joints.

The final covering shall be hammered finish aluminium sheet 1mm thick secured by banding and/or pop rivets ensuring that the vapour barrier is not punctured whilst drilling for pop rivets.

Specification 13.PF.4

Pipework shall be insulated with Zero ODP Foil Faced Phenolic Foam preformed sections.

All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide self-adhesive foil tape in order to provide a permanent and continuous vapour barrier over the insulation. Each 1 metre section of insulation shall be firmly secured by two additional circumferential bands of 75mm wide self-adhesive foil tape at 350mm centres and equally spaced between the sealed joints.

The final finish shall be:

Two full coats of vicryl mastic (of different colours to ensure coverage) with a reinforcing membrane of No. 10 glass cloth embedded between the coats.

Or:

Zero permeability, self adhesive jacketing.

Or:



Fibre reinforced plastic.

Specification 13.PF.5

Internal components shall be insulated with oversized rigid sections faced with Class 'O' factory applied aluminium foil. All joints shall be sealed with suitable adhesive and 75mm wide aluminium tape.

Specification 13.PF.6

Internal components shall be insulated with oversized rigid sections faced with Class 'O' factory applied aluminium foil. All joints shall be sealed with suitable adhesive and 75mm wide aluminium tape.

The insulation shall be covered by hinged boxes fabricated from 1.2mm thick aluminium sheeting and complete with snap toggle fasteners.

Specification 13.PF.7

Internal components shall be insulated with oversized rigid sections faced with Class 'O' factory applied aluminium foil. All joints shall be sealed with suitable adhesive and 75mm wide aluminium tape.

The final finish shall be:

Two full coats of vicryl mastic (of different colours to ensure coverage) with a reinforcing membrane of No. 10 glass cloth embedded between the coats.

Or:

Zero permeability, self adhesive jacketing.

Or:

Fibre re-inforced plastic.

Specification 13.PF.8

Rectangular ductwork shall be insulated with Zero ODP Foil Faced Phenolic Foam laminate. The insulation shall be cut to size on site so that the top and bottom pieces overlap the side pieces at each corner of the duct.

The insulation shall be adhered to the top, bottom and sides of the duct using suitable adhesive. The insulation on the underside of all ducts and on the side of ducts with a depth of 600mm or more shall be additionally secured by means of Insulation Hangers spaced at 300mm centres.

All insulation pieces shall be closely butted together and all joints shall be sealed by means of matching self adhesive tape 75mm wide. Self adhesive tape shall be used to cover the retaining washers on the insulation pins.

Specification 13.PF.9

Rectangular ductwork shall be insulated with Zero ODP Foil Faced Phenolic Foam laminate. The insulation shall be cut to size on site so that the top and bottom pieces overlap the side pieces at each corner of the duct.



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The insulation shall be adhered to the top, bottom and sides of the duct using suitable adhesive. The insulation on the underside of all ducts and on the side of ducts with a depth of 600mm or more shall be additionally secured by means of Insulation Hangers spaced at 300mm centres.

All insulation pieces shall be closely butted together and all joints shall be sealed by means of matching self adhesive tape 75mm wide. Self adhesive tape shall be used to cover the retaining washers on the insulation pins.

The insulation shall be finally covered with:

Hammered finish aluminium sheeting 1mm thick and secured with pop rivets. Care shall be taken to ensure that the aluminium foil is not punctured whilst drilling for pop rivets.

Or:

Zero permeability, self adhesive jacketing.

Or:

PVC jacketing.

Specification 13.PF.10

Rectangular ductwork shall be insulated with Zero ODP Foil Faced Phenolic Foam laminate. The insulation shall be cut to size on site so that the top and bottom pieces overlap the side pieces at each corner of the duct.

The insulation shall be adhered to the top, bottom and sides of the duct using suitable adhesive. The insulation on the underside of all ducts and on the side of ducts with a depth of 600mm or more shall be additionally secured by means of Clipfast Insulation Hangers spaced at 300mm centres.

All insulation pieces shall be closely butted together and all joints shall be sealed by means of matching self adhesive tape 75mm wide. Self adhesive tape shall be used to cover the retaining washers on the insulation pins.

The final finish shall be:

Two full coats of vicryl mastic (of different colours to ensure coverage) with a reinforcing membrane of No. 10 glass cloth embedded between the coats.

Or:

Zero permeability, self adhesive jacketing.

Or:

Fibre re-inforced plastic.

Specification 13.PF.11

Circular ductwork up to 350mm shall be insulated with Zero ODP Foil Faced Phenolic Foam, preformed sections.



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Ductwork over 350mm diameter shall be insulated with Zero ODP Flatwrap slotted Phenolic Foil Faced laminate.

All longitudinal and radial joints shall be tightly butted and sealed with 75mm wide self-adhesive foil tape in order to provide a permanent and continuous vapour barrier over the insulation. Each 1 metre section of insulation shall be firmly secured by two additional circumferential bands of 75mm wide self-adhesive foil tape at 350mm centres and equally spaced between the sealed joints.

The insulation shall be secured to the duct using suitable adhesive and bands of reinforced aluminium foil self adhesive tape at 350mm centres. All joints in the insulation shall be closely butted and sealed by means of matching self adhesive tape.

The insulation shall then be finally covered with:

Hammered finish aluminium sheeting, 1mm thick and secured with banding or pop rivets. Care should be taken to ensure that the aluminium foil is not punctured whilst drilling for pop rivets.

MINERAL WOOL

Specification 13.MW.1

Pipework shall be insulated with mineral wool pre-formed rigid sections faced with factory applied Class 'O' glass fibre reinforced aluminium foil secured with matching self adhesive tape 75mm wide and finally covered with hammered finish aluminium sheeting 1mm thick. The final covering shall have lapped joints.

Specification 13.MW.2

Pipework shall be insulated with mineral wool pre-formed rigid sections faced with factory applied Class 'O' glass fibre reinforced aluminium foil secured with matching self adhesive tape 75mm wide.

Specification 13.MW.3

Pipework shall be insulated with mineral wool pre-formed rigid sections faced with factory applied Class 'O' glass fibre reinforced aluminium foil secured with secured with matching self adhesive tape 75mm wide, and finally covered with hammered finish aluminium sheeting 1mm thick. The final covering shall have lapped joints sealed with suitable metal sealer.

Specification 13.MW.4

Components shall be insulated with hinged boxes fabricated from aluminium sheeting 1.2mm thick and be complete with snap fasteners. Each box shall be lined internally with mineral wool pre-formed insulation faced with factory applied Class 'O' glass fibre reinforced aluminium foil. All insulation shall be of the same thickness as the adjacent pipework insulation, and secured to the inside of the box with suitable adhesive. All joints in the box shall be lapped and arranged to shed water.



Specification 13.MW.5

Vessels shall be insulated with resin bonded mineral wool rigid slabs or flexible mineral wool mat (Crimp Wrap or equivalent) faced with factory applied Class 'O' glass fibre reinforced aluminium foil impaled over nylon hangers attached to vessel surface, secured with matching self adhesive tape 75mm wide finally covered with hammered finish aluminium sheeting 1.2mm thick. The final covering shall have lapped joints arranged to shed water and be sealed with metal sealant and secured with pop rivets. Care shall be taken to ensure that the aluminium foil is not punctured whilst drilling for pop rivets.

At bolted ends, access doors, manhole and stool locations, etc., the insulation shall be finished with purpose made cover plates and collars. Where necessary, suitable steel rings shall be fixed to the vessel shell to provide suitable support for the insulation slabs.

Specification 13.MW.6

Circular ductwork shall be insulated with mineral wool flexible mat faced with factory applied Class 'O' glass fibre reinforced aluminium foil, secured to the duct with suitable adhesive and matching self adhesive tape 75mm wide at 300mm intervals.

Specification 13.MW.7

Circular ductwork shall be insulated with mineral wool flexible mat, faced with factory applied Class 'O' glass fibre reinforced aluminium foil secured to the ducting with suitable adhesive and matching self adhesive tape 75mm wide at 300mm intervals. All joints shall be sealed with suitable adhesive. The insulation shall be finally covered with aluminium sheeting 1mm thick, having lapped joints arranged to shed water, sealed with metal sealant and secured with pop rivets. Care shall be taken to ensure that the aluminium foil is not punctured whilst drilling for pop rivets.

ELASTOMERIC FOAM

Specification 13.EF.01

Pipework shall be insulated with Elastomeric Foam Class 'O' insulation with a thickness of 15mm.

All joints shall be sealed with non-flammable adhesive, with all fittings insulated to maintain the maximum insulation thickness.

Specification 13.EF.02

The installation shall be insulated with Elastomeric Class 'O' insulation with the following thickness :-

Pipe Diameter 15mm	:	20mm
Pipe Diameter 20mm	:	20mm
Pipe Diameter 25mm	:	25mm

All joints and seams shall be sealed with non-flammable adhesive to maintain a continuous vapour barrier.



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All valves and fittings and the like, shall be insulated to maintain a continuous thickness of insulation and vapour seal using fabricated fitting covers and oversized pipe sections, all fitted in accordance with the manufacturer's instructions.

Specification 13.EF.03

The installation shall be insulated with Elastomeric Foam Class 'O' insulation with the following thickness :-

Pipe Diameter 15mm : 20mm

Pipe Diameter 20mm : 20mm

Pipe Diameter 25mm : 25mm

All valves and fittings and the like, shall be insulated to maintain a continuous thickness of insulation and vapour sealed using fabricated fitting covers and oversized pipe sections, in accordance with the manufacturer's instructions.

Specification 13.EF.04

Refrigeration pipework shall be insulated with Elastomeric Foam Class 'O' insulation, protected with a continuous vapour barrier which shall not be broken between joints of sectional material nor at discontinuities, such as valves and fittings, supports and the like.

Refrigeration expansion lines suction pipes from the evaporator to the compressor and discharge pipes shall, unless otherwise indicated, have insulation applied at a minimum thickness as follows :-

Pipes up to and including 80mm size : 12mm

Pipes 100mm size and above : 19mm

Liquid refrigerant pipes external to the buildings and subject to solar gain shall either be shielded or have 12mm thickness of weatherproof closed cell insulation applied with a reflective or light coloured finish.

CALCIUM SILICATE

Specification 13.CS1

Ductwork and equipment shall have a 25mm air space formed around it by means of 13mm mesh x 0.5mm galvanised iron expanded metal secured on lugs and bobbins coated with 13mm thickness calcium silicate plastic composition then insulated with calcium silicate pre-formed rigid slabs securely wired on with 1mm galvanised iron lacing wire reinforced with a layer of 25mm mesh x 1mm galvanised iron wire netting finally covered with hammered finish aluminium sheeting 0.9mm thick.

All joints of the covering shall be lapped to shed water and sealed with Foster 81-33 sealant and stainless steel self tapping screws or pop rivets. The underside of all horizontal runs shall be perforated with 6mm dia. drainage holes at 150mm centres.



C13.17 PIPEWORK INSULATION THICKNESS – ZERO ODP PHENOLIC FOAM (for temperatures up to 80°C)

Nominal Pipe Size mm	Service and Insulation Minimum Thickness mm					
	Condensate 100°C max.	LTHW 75°C max.	DHWS 65°C/75°C max.	CWS 10°C max.	Chilled Water 5°C min.	Cold Feed & Vents 10°C
15	N/A	15	15	15	20	15
20/22	N/A	20	15	15	20	15
25/28	N/A	20	20	15	20	15
32/35	N/A	20	20	15	20	15
40/42	N/A	20	20	15	25	15
50/54	N/A	25	25	20	25	20
65/67	N/A	25	25	20	25	20
80/86.1	N/A	25	25	20	25	20
100/108	N/A	25	25	20	30	20
125/133	N/A	30	30	20	30	20
150/159	N/A	30	30	25	30	25
200	N/A	30	30	20	35	25
250	N/A	30	30	25	35	25
300	N/A	35	35	25	35	25

Vessels	N/A	35	35	30	40	30
In accordance with BS 5422: 2001	Table 12	Table 12	Table 13	Table 8	Table 8	Table 8

Note: The above thicknesses for cold and chilled water services are in accordance with BS 5422 : Table 7 for condensation control on a low emissivity finish. Thicknesses for frost protection are given in Section C13.22.

On valves, expansion bellows and flanges, the insulation shall be the same thickness as the adjacent pipework.

For services at different temperatures and pressures refer to BS 5422 and BS 5970. The revised insulation thicknesses shall be agreed with the Services Engineer prior to installation of the insulation.



C13.18 PIPEWORK INSULATION THICKNESS - MINERAL WOOL (Water Repellent Non-Hygroscopic)

Nominal Pipe Size mm MS/Cu	Service and Insulation Minimum Thickness mm								
	DHWS 65/75 C	Steam 8.3 bar.g 177°C Max.	Condensate 100°C max.	MTHW 100°C max.	LTHW 75°C max.	NON DOMESTIC HWS 60°C max.	CWS 10°C max.	Chilled Water 5°C min.	Cold Feed & Vents
15	30	60	40	40	30	30	20	25	30
20/22	40	60	40	40	30	30	20	30	35
25/28	45	60	40	40	35	30	20	30	35
32/35	45	70	45	45	35	35	25	30	40
40/42	45	70	45	45	35	35	25	35	40
50/54	45	80	50	50	40	40	25	35	45
65/67	50	80	50	50	40	40	30	35	45
80/86.1	50	90	60	60	40	40	30	40	50
100/108	50	90	60	60	45	45	30	45	50
125/133	50	100	60	60	45	45	30	50	60
150/159	50	100	60	60	45	45	35	60	60
200	50	110	60	60	50	50	35	60	60
250	50	120	60	60	50	50	40	60	70
300	50	120	60	60	50	50	40	60	70

Vessels	60	130	70	70	50	50	50	70	80
In accordance with BS 5422:2001	Table 14	Table 15	Table 12	Table 12	Table 12	Table 13	Table 8	Table 8	Table 8

Note : The above thicknesses for cold and chilled water services are in accordance with BS 5422 : Table 7 for condensation control on a low emissivity finish. Thicknesses for frost protection are given in Section C13.22.

On valves, expansion bellows and flanges the insulation shall be the same thickness as the adjacent pipework.



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For services at different temperatures and pressures refer to BS 5422, and BS 5970. The revised insulation thicknesses shall be agreed with the Services Engineer prior to installation of the insulation.

C13.19 WARM AIR DUCTWORK INSULATION THICKNESS (Based on BS 5422 : 2001, Table 11)

Supply air duct work carrying warmed air, excluding ductwork between inlet louvre and 1st heater or cooler battery, shall have insulation of the type and thickness detailed in the following table.

Temperature difference between air inside the ductwork and ambient air	Phenolic Foam Thickness mm	Mineral Wool Thickness mm
10°C	20	40
25°C	30	50
50°C	35	60

C13.20 CHILLED AIR DUCTWORK INSULATION THICKNESS (Based on BS 5422 : 2001, Table 10)

Supply air ductwork carrying chilled air, excluding ductwork between inlet louvre and 1st cooler battery, shall have insulation of the thickness detailed in the following table.

Minimum air temperature inside the ductwork	Phenolic Foam Thickness Mm	Mineral Wool Thickness Mm
10°C	30	50
5°C	40	65
0°C	50	90

C13.21 PLANT INSULATION THICKNESS

Plant shall have insulation of the type and thickness detailed in the following table.

Equipment	Phenolic Foam Thickness mm	Mineral Wool Thickness Mm
Domestic Hot Water Calorifiers	25	60
LPHW Calorifiers and Heat Exchangers	35	60
Hot Wells	40	75



C13.22 FROST PROTECTION

All water pipework installed internally in unheated areas of the building, externally above ground level and where the pipework enters the building, shall be installed with trace heating as described in the section headed 'Electric Trace Heating of Pipework Services' included elsewhere in this specification and finally insulated with either Class 'O' Elastomeric Foam having a thermal conductivity of 0.040 w/MK or Zero ODP foil covered phenolic foam, as detailed in this section of the specification.

Frost protection insulation shall have a minimum thickness, as detailed in the following table. In instances where pipework enters a building within 750mm of the external facade, the pipework below ground shall be insulated in its vertical length and in its horizontal length up to 1m from the external face of the building or structure.

All insulation in exposed locations external to buildings shall be provided with a weatherproof finish.

All pipework, valves and fittings and the like, shall be insulated and vapour sealed to maintain a continuous thickness of insulation.

All valves and fittings and the like, shall be insulated using fabricated fitting covers and oversized pipe sections, all fitted in accordance with the manufacturer's installation manual.

Nominal Outside Diameter of Pipe mm	Insulation Thickness mm			
	Elastomeric Foam		Phenolic Foam	
	Indoor	Outdoor	Indoor	Outdoor
Up to and including 15	32	38	20	25
22 and up to and including 42	32	38	20	25
54 and up to and including 76.1	32	32	20	20
Over 76.1	22	25	20	20

Note : For further information on Frost Protection under various design conditions, refer to BS 5422 : 2001, Section 11, Table 22, 23, 24 and 25.

C13.23 AMBIENT TEMPERATURES

Unless otherwise stated in this specification, the ambient temperature shall be taken as 21°C summer and -7°C winter.



C13.24 GENERAL NOTES

1. Insulation thicknesses listed above are based on:-

Zero ODP Phenolic Foam (CFC & HCFC free) :	
Pipework : Preformed Sections	0.021 W/mK at a mean temperature of 10°C, and density of 35Kg/m ³
Ductwork : Laminated Slabs	0.021 W/mK at a mean temperature of 10°C, and density of 40Kg/m ³

Glass based Mineral Wool - Water Repellent & Non-Hygroscopic	
Pipework : Pre-formed Sections	0.035 W/mK at mean temperature of 50°C and nominal density of 75 Kg/m ³
Circular or Oval Ductwork Flexible Insulation :	0.034 W/mk at a mean temperature of 10°C and minimum nominal density of 24 Kg/m ³
Rectangular Ductwork Rigid Insulation :	0.030 W/mK at a mean temperature of 10°C and density of 32 Kg/m ³

Elastomeric Nitrile Rubber - Class O Grade	
Pipework :	0.040 W/mK at a mean temperature of 0°C, and nominal density of 60 Kg/m ³

Calcium Silicate - Substitute for Mineral Wool in NON-FIBROUS areas	
Pipework : Sections and Slabs	0.055 W/mK at a mean temperature of 50°C, and density of 210 Kg/m ³
Ductwork : Sections and Slabs	0.055 W/mK at a mean temperature of 50°C, and density of 210 Kg/m ³



PART C - SECTION 14 PIPEWORK IDENTIFICATION

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PART C - SECTION 14

PIPEWORK IDENTIFICATION

C14.1 GENERAL

Where applicable, pipework identification shall comply with BS 1710.

C14.2 POSITIONING OF COLOUR CODES

Identifying colour bands indicated in Tables 1, 2, 3 and 4, shall be positioned at:-

1. All junctions.
2. Both sides of each valve.
3. Both sides of any wall or partition through which the pipe passes.
4. Each change of direction in pipeline.
5. A maximum distance of 2400mm (8 ft) on straight lengths of pipe.

Identification bands shall be incorporated on all service lines and be in accordance with the typical details included in Part 'D'.

C14.3 BASIC IDENTIFICATION COLOURS

Table 1

Pipe Contents	Basic Identification Colour	BS Colour Ref. BS 4800
Water	Green	12 D 45
Steam	Silver-Grey	10 A 03
Mineral, vegetable and animal oils; combustible liquids	Brown	06 C 39
Gases in either gaseous or liquidified condition (except air)	Yellow Ochre	08 C 35
Acids and alkalis	Violet	22 C 37
Air	Light Blue	20 E 51
Other Fluids	Black	00 E 53
Electrical Services	Orange	06 E 51

NOTE The Colours given in column 2 are only included for guidance since different colours names may be used by different manufacturers for the same colour reference.



C14.4 SERVICES IDENTIFICATION COLOURS

Table 2

Pipe Contents	Basic Colour (approx. 150mm)	Colour Code Indication (approx. 100mm)	Basic Colour (approx. 150mm)
<u>WATER</u>			
Drinking	Green	Auxiliary Blue	Green
Cooling (Primary)	Green	White	Green
Boiler Feed	Green	Crimson White Crimson	Green
Condensate	Green	Crimson Em. Green Crimson	Green
Chilled	Green	White Em. Green White	Green
Central Heating <100°C	Green	Blue Crimson Blue	Green
Central Heating >100°C	Green	Crimson Blue Crimson	Green
Cold, Down Service	Green	White Blue White	Green
Hot Water Supply	Green	White Crimson White	Green
Hydraulic Power	Green	Salmon Pink	Green
Sea, river, untreated		Green	
Fire extinguishing	Green	Red	Green
COMPRESSED AIR		Light Blue	
VACUUM	Light Blue	White	Light Blue
STEAM		Silver Grey	
DRAINAGE		Black	
ELEC. CONDUITS & DUCTS		Orange	



TOWN GAS Manufactured Gas	Yellow Ochre	Em. Green	Yellow Ochre
Natural Gas	Yellow Ochre	Primrose	Yellow Ochre
OILS			
Diesel Fuel	Brown	White	Brown
Furnace Fuel		Brown	
Lubricating	Brown	Em. Green	Brown
Hydraulic Power	Brown	Salmon Pink	Brown
Transformer	Brown	Crimson	Brown
ACIDS & ALKALIS	Violet		

(Colour names are given for guidance. When specifying colours, colour references given in Tables 1, 3 and 4 shall be stated).

C14.5 SAFETY COLOURS

Table 3

Safety Colour	Colour Reference (BS 4800)
Red	04 E 53
Yellow	08 E 51
Auxiliary Blue	18 E 53

NOTE The colours given in column 1 are only included for guidance since different names may be used by different manufacturers for the same reference.



C14.6 REFERENCE COLOURS

Table 4 (if other than safety colours) not previously specified in Tables 1 or 3.

Colour	Colour Reference (BS 4800)
Crimson	04 D 45
Emerald Green	14 E 53
Salmon Pink	04 C 33
Yellow	10 E 53

C14.7 DIMENSIONS OF COLOUR CODING BANDS

Dimensions of colour coding shall be in accordance with the typical details included in Part 'D'.

C14.8 METHOD OF APPLICATION OF COLOUR CODING BANDS

Identification shall be applied in accordance with the typical details included in Part 'D' and be either :-

1. Painted on the pipe as a band to the dimensions indicated.
2. Painted on a band to be permanently fixed to the pipe to the dimensions indicated.

On pipework with colour banding the decorative or protective finish on the pipe shall not be any of the basic identification colours.

Valves shall be painted with the identification colour with the following exception:-

1. If the pipeline has been coded with the safety colour for fire fighting, the valves shall be painted red.

C14.9 PIPE CONTENTS INDICATION

Information such as the name of the contents, pressure, temperature and direction of flow shall be placed next to the basic identification colour band. The names, arrows, and the like shall be either in white or black in order to contrast clearly with the colour of the pipe and shall be placed either directly on the pipe or on a permanent fixing to the pipe.

On flow and return pipework further indication shall be done by means of the word FLOW on the flow pipe and RETURN on return pipework.

When contents indication is given in conjunction with a safety colour, the indication shall have a background the same colour as the safety colour.



C14.10 VALVE IDENTIFICATION DISCS

Each valve disc shall indicate the colour codes of the service to which it is attached, contents, temperature and the number of the valve relating to the layout of the particular installation. Disc specification shall be in accordance with the typical details included in Part D.

Discs shall be attached to valves by means of brass chains and key rings.

C14.11 IDENTIFICATION OF ANCILLARY PIPEWORK

Ancillary pipework e.g., cold feeds and vent pipes shall be colour coded as the service to which they are connected. In addition, a label shall be provided adjacent the colour coding to indicate the purpose of the service (e.g., 'heating cold feed').



PART C - SECTION 15 AUTOMATIC CONTROLS

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PART C - SECTION 15

AUTOMATIC CONTROLS

C15.1 GENERAL

The total automatic controls installation, including interconnecting wiring shall form part of the Works described in this specification and a 'Controls Engineer' shall be solely responsible for the entire Automatic Controls installation.

The Controls Engineer shall supply all equipment and interconnecting wiring necessary for the satisfactory operation of the plants and installation, whether specified in detail or not and shall upon completion of the installation satisfactorily test and commission all the controls.

The extent of the Automatic Controls installation shall be as detailed in the Schedule of Technical Requirements, contained within Part 'D' of this Specification.

All necessary cable tray, piping, wiring, fittings and fixings required for the complete Automatic Controls installations, shall be supplied installed tested and commissioned.

Any Automatic Control equipment fitted into the works which is not installed by the Controls Engineer shall have its installation supervised by the Controls Engineer.

Temperature detectors installed in a tank, calorifier, or pipeline shall be protected with a separate pocket of suitable material. Detector pockets and items of Controls equipment shall be installed in the pipework and ductwork systems in the positions determined by, and under the supervision of the Controls Engineer.

Unless otherwise indicated in this specification, all electrical actuators and linkages and mechanisms shall be provided by the Controls Engineer to suit motorised dampers, valves, and the like as necessary. This shall include the provision of motor(s) of adequate power and suitable linkage mechanism(s) on each motorised damper to enable operating motor(s) to properly drive the damper blades to their correct position. The Controls Engineer shall supervise the installation of all such linkage mechanisms.

Unless otherwise specified all necessary information regarding loads and duties of equipment shall be obtained by the Controls Engineer from the Sub-Contractor, and the tender prepared accordingly. This shall include, but not be limited to, the following where applicable:-

- Motor sizes (rating, full load current and number of phases)
- Electrical supply details
- Heater battery flow rates and pressure drops
- Cooling Coil flow rates and pressure drops
- LPHW valve requirements (i.e. flow rates and circuit pressure drops)
- Damper motor requirements

When ordering the control panels, final confirmation of the above information shall be given to the Controls Engineer. All starters for motors rated at over 5.0 kW shall be star-delta and all two speed motors shall be of the dual wound type.

Unless otherwise specified all 3 port valves shall close to load when switched off.

Unless stated otherwise, starters for all mechanical services equipment shall be provided by the Controls Engineer and housed in the control panels.



Where air-flow failure sensors are specified, these shall be of the pressure differential type. Anti-flutter timers shall be provided in the panel for these sensors.

Where pressure differential sensors are specified, the Controls Engineer shall provide suitable plastic tube, clipped and secured as necessary, from the controller to the positions where the pressure is being monitored.

Where specialist equipment is supplied under the sub-contract, the content of this specification section is deemed to apply to this equipment also.

C15.2 CONTROLS ENGINEER'S RESPONSIBILITY

The details in this section of the Specification and associated drawings indicate the design intent for the operation of the controls. It is the Controls Engineer's responsibility to verify and ensure the controls specified, both in quantity, size and type, and their mode of operation, fully comply with the design intent shown, and provide a complete installation.

The Controls Engineer shall select the correct type of, and confirm the position of all sensors, thermostats, controllers, and the like to the Sub-Contractor and ensure that they are in a location that will enable correct operation of the systems.

The Controls Engineer shall carry out all site revisions necessary to the Controls Installation in order to provide the specified description of operations.

Wiring diagrams, general arrangement drawings for all control panels, and the required location of all items of equipment associated with the controls installation shall be indicated on drawings prepared by the Controls Engineer and submitted to the Services Engineer for comment, via this Section of the Works, all being in accordance with the provision of installation drawings detailed elsewhere within Part B of this Specification.

All controls wiring diagrams submitted for comment shall be accompanied by a complete description of the operation of the automatic controls systems and Control Function Diagrams (CFD's). Details of any special wiring requirements (i.e., screened cables or any wiring additional to that indicated on the tender drawings), necessary to ensure the correct operation of each controls system, shall be submitted with the tender offer and be included on the above diagrams.

The Controls Engineer shall demonstrate in full to the Services Engineer, the satisfactory operation of the entire controls installation and associated mechanical services systems that it serves. Allowance shall also be made for separate similar demonstrations to the Client's representative.

C15.3 MULTI MOTOR PANELS, CUBICLE TYPE SWITCHBOARDS, CONTROL CUBICLES AND WARDROBE PANELS

Control panels shall comply with the EMC Directive and BRE Digest 424 (BRE 1997) in respect to electromagnetic interference.

Multi motor panels shall consist of a number of starters mounted together under a common isolator.



Cubicle type switchboards shall consist of a number of separate sheet steel cubicles each containing motor starters having their own isolator and fuses together with any necessary control switches and accessories. Complete access to the individual units shall be provided by means of hinged lockable doors, but the switchboard shall be designed so that access to 'live' metal will not be gained by opening the hinged door of the unit.

Busbars and busbar connections shall be constructed in accordance with BS EN 60439-1 and BS 159. Busbars shall be made of hard drawn high conductivity copper; rated as specified. The busbars and connections shall be capable of withstanding the specified short circuit conditions.

Panels which are of cubicle construction, i.e. a number of separate compartments each completely enclosed shall be incorporated into the panels as follows :-

1. Compartments for motor controls incorporating :
 - 1.1 Door interlocking fused isolator; this isolator must also isolate the starter coil circuit and any control circuits entering the compartment at and over 240V.
 - 1.2 Motor Starter.
 - 1.3 Door mounted switches and lamps.
 - 1.4 Door mounted indicating equipment.

Note: One compartment is required for each motor.

2. A separate compartment is required for control switches, lamp assemblies, and the like which are associated with two or more motor compartments, i.e. duty change-over switches, or switches for controlling external items of plant which are not associated with a motor compartment e.g., switches to control supplies to refrigeration control panels, time switches for remote valves, and the like. This compartment shall have a lockable door, three keys being provided. Lamps and control switches to be front panel mounted.
3. Where the plant has a standby motor i.e., there are two cubicles, the automatic control and monitoring equipment shall be incorporated into a separate compartment situated between the two motor cubicles. This separate compartment shall have a door interlocking isolator which shall isolate all the incoming circuits in order that maintenance can be safely carried out and a door mounted No.1 / No.2 selector switch.
4. The door interlocking isolator specified above shall be so arranged that it shall not be possible to close the switch with the door open, except that provision shall be made within the compartment for an authorised person to defeat the mechanical interlock and close the switch with the door in the open position for test purposes.
5. Any automatic control or monitoring equipment i.e., compensator, time switches, dirty filter lights, which are associated with a specific plant shall be incorporated into the motor compartment serving that plant, providing that plant does not have a standby motor.
6. Any Data Gathering Panels associated with a Central Processor which are to be incorporated within the panels shall be contained within a separate controls compartment.



7. Control cubicles shall comprise sheet steel enclosures minimum thickness 2mm, dust and damp protecting index of protection IP.522. The sheet steel shall be zinc coated and chromate washed and finished with one coat of rust inhibitive primer followed by two coats of light orange acrylic enamel to BS 381C, applied wet and stoved. Cubicle interiors shall be finished white acrylic enamel.
8. Cut-outs shall be accurately cut and all edges finished smooth and free from burrs and burns.
9. All doors shall be hinged and gasketed.
10. A removable drilling plate shall be provided adjacent to the point of cable entry for cable glands and conduit terminations.
11. Where practical, components shall not be mounted on panels capable of movement e.g., doors.
12. For all floor mounting panels removable lifting lugs shall be provided.
13. All handles and locks shall be chromium plated.

Wardrobe type control panels shall be generally as described in Clause C15.14.5.

Labels and Component Identification

1. The type, material and method of fixing labels shall be to the Engineer's approval.
2. Each panel shall carry a warning label stating 'Danger' and the voltage present, in 13mm high red letters on a white background.
3. Each control and indicating device on the front of the panel shall have its function marked adjacent to it.
4. Each multi-position switch on the front of the panel shall have the function of each marked adjacent to it.
5. Components shall be labelled with schematic circuit diagram identification reference.

Cable numbers as the schematic circuit diagram shall be indicated by suitable markers on cable ends. The ends of each connection shall be fitted with crimp terminal tags.

Components (General)

Components used in control panels shall comply with the following British Standards:-

Busbars and busbar connections	BS 159 and BS EN 60439-1
Motor starters and controllers	BS EN 60947-4-1 and BS 5856 : Part 1 and BS EN 60439-1
Contactors	BS 775 and BS 5424
Air break switches and isolators	BS EN 60947-3



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Heavy duty composite units of
air-break switches and fuses

BS EN 60947-3

Colours of indicator lights and
push buttons

BS EN 60073

The performance of A.C. motor
control gear equipment up to
1000V A.C. for use on high
prospective fault current systems.

BS 5486, BS EN 60439-1 and BS EN
60947

HRC fuses - ASTA, indicating pattern to BS 88, category of duty 440 AC5.

1. Measuring Instruments

- 1.1 All instruments shall be flush panel mounted and all bezels and escutcheon plates shall be Colour 557.
- 1.2 The scale length of all indicators and recorders shall be slightly less than the full travel of the instrument so that there is a clear indication when the pointer is off scale.
- 1.3 The instrument ranges shall be so arranged that the normal working indication is at a point approximately two thirds of the full scale deflection.
- 1.4 All instrument scales shall have black divisions on a white background.

2. Indicator Lamps

- 2.1 The colour of indicator lamps shall be:-

Machine Running	GREEN
Machine Stopped	RED
Machine Failed	RED
Supply On	GREEN

- 2.2 Indicator lamps may be of the neon or LED Cluster type.

3. Push Buttons

The colour of push buttons shall be:-

Start	GREEN	Full Guard
Stop (normal)	RED	Half Guard
Emergency Stop	RED	Mushroom Head
Stop (lockout)	RED	Mushroom Head

With main contact assembly:-

Re-set	GREY	Full Guard
Inch forward	BLACK	Full Guard
Reverse. Misc.	BLUE	Full Guard

The above colour code applies also to illuminated push buttons. All push buttons shall be oil tight pattern and legend plates shall be provided.



4. Time Switches

Each time switch shall incorporate a spring reserve to enable it to function for a period of at least thirty hours after interruption of the supply.

5. Contactors

Each contactor shall be suitable for the electrical and mechanical duty it has to perform.

6. Starters

Each starter shall be suitable for the electrical and mechanical duty it has to perform and as detailed later in this section of the Specification.

Component Mountings

1. Components shall be so mounted that they can be inspected, removed and replaced without damage or undue disturbance to other components or wiring.
2. Where a component has a single point mounting, positive means of preventing rotation of the component body relative to the mount shall be provided.
3. Components shall not be secured by means of self-tapping screws.
4. Lock washers shall be used on all screws.

Circuitry

1. Panel Supplies

- 1.1 An 'on-load' multi-pole isolator capable of isolating the supply to the panel shall be provided.
- 1.2 A 'Panel Alive' indicator lamp shall be provided.
- 1.3 Where a supply to components is required independent of the panel isolator or a supply is fed back into the panel from another source, the components and associated wiring shall be housed in an earthed metal enclosure. The front of the enclosure carrying a label stating 'Danger', the voltage present and the source of the supply in red letters on a white background.
- 1.4 Where Mains Supply / Emergency supply change-over is specified the equipment shall be so interlocked electrically and mechanically that on mains supply being resumed, the equipment shall automatically change back to that supply. 'Mains Supply On' and 'Emergency Supply On' indicator lamps shall be provided.

The method of change-over to essential supplies shall be by one of the following methods as detailed on the drawings :-

- 1.4.1 A relay shall be incorporated in the control circuit feeding the essential equipment. This relay shall operate from a separate external source, this source being the normal mains supply. On loss of the normal mains supply the contacts of the relay shall be closed to allow the essential equipment to operate.



- 1.4.2 The equipment which is to be served from the emergency supply shall be grouped separately from the non essential equipment.

Two sources of supply are to be provided, each feeding separate bus bars, one for essential supplies fed from the generator and one for normal supplies. The Panel isolator shall isolate both supplies with a multi-pole switch.

2. Control Circuits

Each group of control circuits shall be supplied via a separate fuse and have a 'Control Circuit Fuse Failed' indicator lamp.

Each starter shall be provided with one or more of the following control circuits as specified :-

- 2.1 3-wire control circuit for use at line to neutral voltage but with links to facilitate use on 2-wire control. The circuit shall be complete with control fuse and neutral link.
- 2.2 An intrinsically safe control circuit to BS EN 50020 and BS EN 50018 : Parts 7 and 9, arranged for 3-wire control but with links to facilitate use on 2-wire control. The circuit shall be complete with control fuse and neutral link.
- 2.3 A test switch within each starter enclosure to facilitate testing the contactor mechanism and control system without applying power to the motor.
- 2.4 Start/stop buttons on the front panel with terminals and links for use with remote stop/start station and/or remote latch out 'emergency stop' station.

3. Motor Circuits

- 3.1 Each motor supply circuit shall be provided with H.R.C. fuses. Each motor circuit incorporating a star-delta starter shall be provided with a remote lockout isolation circuit.
- 3.2 Each motor circuit shall be provided with 'starter closed' and 'starter tripped' indicator lamps. The supply for the 'starter closed' indicator lamp shall be via an auxiliary contact on the starter. The supply for the 'starter tripped' indicator lamp shall be controlled by an auxiliary contact on the overload device.
- 3.3 Where duplicate motors are required for a single function a selector switch shall be provided to select the motor required and ensure that only that motor can be in operation.
- 3.4 When automatic starting of a second motor on the 'tripping' of the first is required, a selector switch shall be provided to select the motor to be first in line.
- 3.5 Where the switching on of a number of motors together may cause a supply fuse to fail, timers shall be provided to stagger the switching on.



4. Audible Alarm Circuits

Where an audible alarm is specified an 'Alarm Accept' push button shall be provided to silence the alarm. The alarm circuit shall be such that silencing the alarm for one condition does not render it inoperative for any other condition.

Panel Wiring

1. Wiring shall be P.V.C.-insulated and adequately rated.
2. Wiring shall be suitably colour coded according to circuit.
3. Multi-strand conductors shall be used where flexing of wire is expected.
4. The radius of bends in wires shall be not less than the manufacturer's recommended value.
5. Long runs of wiring shall be adequately supported, the supporting arrangement not causing permanent physical damage or deformation to the conductors or insulation. Where practical, wiring shall be run in such a manner that it can be checked against diagrams without removing supports.
6. Wires shall not be laced.
7. Where wires pass through metal structures or structures liable to cause damage, insulated grommets or bushes shall be used.
8. All wiring for control and power circuits shall be segregated.
9. All wiring shall be segregated from pipework containing steam, water, oil, and the like.

Earthing

1. An earth terminal shall be provided.
2. Each component shall be suitably earth bonded.
3. Where equipment is mounted on a separate frame a flexible tinned copper braid shall interconnect the frame and the earth terminal.
4. A separate flexible tinned copper braid shall bond each door to the panel.
5. Surfaces of all equipment to which earthing connections are made shall be cleaned free from paint and other non-conducting material.

Terminals

1. Terminals shall be of an adequate rating and identified in accordance with the wiring diagram.
2. Pinch type terminals shall not be used.
3. Outgoing circuits shall be brought to terminals adjacent to the point of cable entry, this position being specified.



Spares

1. Three spare fuses for each rating of fuse used shall be provided and clipped inside the panel.
2. Three spare indicator lamps of each type shall be provided and clipped inside the panel.

Testing

1. All wiring and earth bonding shall be tested for continuity and correct identification with the wiring diagram.
2. All wiring shall be tested for insulation to earth.
3. Thermocouple circuits shall have their polarity proved.

Protection of Panel

Each panel shall be protected against damage during transit, storage, erection, commissioning and testing. Any damage shall be made good at no expense to the Client.

Drawings

1. Graphical symbols shall be in accordance with the current edition of BS EN 60617.
2. The following drawings shall be submitted for approval before panel manufacture commences:-
 - i) Circuit Diagram.
 - ii) Panel Arrangement.
 - iii) Panel Fascia.
 - iv) External Wiring Connections.
3. A copy of the wiring diagram shall be provided on plastic material within each panel.

Specific Requirements

The control panel shall have the following specific facilities:-

1. When essential and non-essential sections are required (e.g., Operating Theatre Panels), the panel shall be segregated into essential and non-essential sections using a split bus bar system. Essential supplies shall include all equipment except for chilled water plant.
2. Ammeters shall be provided and mounted on the compartment door for each motor.

Electrically insulated mats, conforming to the Low Voltage Electrical Equipment (Safety) Regulations 1989 and of suitable dimensions, should be provided in front of each switchboard, panel or controller and also where necessary at the rear.



C15.4 A.C. CONTACTOR STARTERS

Starters shall comply with BS EN 60947-4-1 and BS 5856 for auto-transformer, and the like and be suitable for the mechanical and electrical duty specified. All enclosures shall be primed and finished to an approved BS Colour.

Each starter shall be provided with an isolating switch capable of making and breaking the stalled current of the controlled motor and shall be in accordance with BS EN 60947-3. Contactors shall comply with BS 5424 and BS EN 60947-4-1. In addition, the isolator shall have the facility of being able to be locked in the 'Off' position. Where required additional poles shall be provided for connection into auxiliary circuits such that the starter interior shall be completely isolated from all supplies upon operation of the switch.

When required starter enclosures shall be fitted with an anti-condensation heater. The heater shall be designed to operate on line to neutral voltage and the circuit shall be taken from the 'live' side of the line isolator to the control circuit neutral. The heater fuse shall be of the insulated withdrawable type housed in the isolator compartment and marked 'Heater Fuse'. The heater and its lead shall be fully shrouded to enable maintenance work on the starter to be carried out in safety whilst the heater is still 'alive'. A warning label reading 'Heater Circuit Alive' shall be visible when the cover is open.

C15.5 SPEED CONTROL INVERTERS

Each speed control inverter shall be a pulse width modulation inverter and comply with the requirements of the following standards :-

IEC 68-2-6, 34-36	Vibration Standard
VDE 0106/0160	Galvanic isolation
VDE 160 cl.w2	Mains Transients
IEC 801-4	Burst
IEC 801-5	Surge
SEN 361503	Mains Conducted RFI
IEC 601-2	ESD
IEC 801-3	Radiated Electromagnetic Field
G5/3	Electricity Council Engineering Recommendation

Each speed control inverter shall use voltage vector control to digitally control the timing of the output pulses.

Each inverter shall be sized to allow for the margin required on the size of each motor, as detailed in the clause Equipment Selection contained in Part 'B' of this specification.

Each inverter shall be manufactured by a Company holding full accreditation for manufacture of the units in accordance with BS EN ISO 9001.

Each inverter shall provide near unity power factor at all speeds and loads without any external power factor correction equipment.

Each inverter shall be suitable for mounting within a Control Panel or floor standing within a steel enclosure rated to IP54 Standard.

Unless otherwise specified, a keypad control shall provide running and fault diagnostic information and there shall be a hardware provision to inhibit the use of the keypad.



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Each inverter shall be capable of controlling a standard three phase asynchronous motor over a speed range between 0-100% of pole speed without the need to de-rate the nameplate power rating.

Each inverter shall have facilities for being operated from either the keypad or from a remote signal for stop/start, preset speed, trip reset and speed control.

Each inverter shall provide as standard, RFI protection to VDE 0875 curve N. Documentation showing compliance to this standard must be made available on request.

Four skip frequencies shall be available to overcome mechanical or system resonating.

The drive shall automatically trip if the heat-sink rises above 75°C, an alarm condition shall be identified on the control system.

Each inverter shall contain as standard, a PI controller to provide closed loop control to maintain pressure or flow if required.

Full galvanic isolation shall be provided to achieve compliance with Protective Extra Low Voltage (P.E.L.V.) requirements of VDE 0160.

Each inverter shall be capable of withstanding the effects of accidentally connecting the mains input directly to the motor output terminals.

Each inverter (rectifier) shall be controlled by thyristors and not diodes.

Each inverter shall include a tuned L.C. filter to limit the mains harmonic distortion.

Each inverter shall include motor output chokes to control the DU/DT.

The output current must be measured on all three output phases to ensure complete protection against loss of motor phase, motor short circuit and motor circuit earth fault.

The motor circuit shall be capable of being switched by a three phase contactor/isolator without the need for control circuit interlocking. This switching must not cause damage to the inverter.

The drive shall monitor all three supply phases and shall be able to withstand a mains supply interruption of up to 500ms without tripping. Mains supply interruption of greater than 500ms shall automatically shut down the inverter.

Each inverter shall allow for the use of motor cables up to 300 metres in screened cable and 150 metres in unscreened cable, without the use of additional motor chokes.

Armouring shall not require any special earthing arrangement other than bonding at both the inverter and the motor.

Rated motor voltage and torque shall be maintained at 10% under voltage on the mains input.

Each inverter shall protect the motor against overheating by a thermal motor model within the drive.

Each inverter shall include as standard, a digital equivalent to a 'motor operated potentiometer'.



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Each inverter shall automatically reduce its current rating if the switching frequency is increased above the factory setting of 4.5 kHz. The full switching frequency shall be adjustable between 3.95 kHz to 14 kHz.

Inverters shall be provided with 12 pulse rectifiers.

The cable between the inverter and the motor shall be screened type throughout its entire length.

C15.6 PROTECTION AND METERING

Each starter shall be provided with one or more of the following protective devices as specified :-

1. Three pole overload and single phasing protection by means of a thermal relay, hand re-setting pattern with automatic adjustment for ambient temperature changes.
2. Overcurrent trip coils operating in conjunction with fluid dash pot time lags.
3. Inherent 'no-volt' release feature.
4. Three pole overload, instantaneous earth fault and single phasing protection by means of a thermal protection relay.
5. Instantaneous earth fault relay with flag indicator, core-balance current transformer operated.
6. Three pole thermistor protection relay.
7. Short circuit protection on each phase by an H.R.C. cartridge fuse to BS 88 and BS EN 60269.

C15.7 STARTER METERING

Where required, starters shall be provided with an ammeter arranged for full load reading between half and three-quarters full scale reading. A line indicating the full load current of the motor shall be marked in red on the scale.

The ammeter shall be designed in accordance with BS EN 60051. Where required, starters shall be fitted with an 'hours run' indicator on the cover of the instrument.

Current transformers and voltage transformers for use with protective devices and measuring instruments shall conform to the requirements of BS 7626 and BS EN 60044-5 respectively.

C15.8 LOOSE EQUIPMENT

Each separate item of equipment supplied loose such as a detector, thermostat, damper actuator, motorised valves etc., shall be clearly identified with its function and position, with screwed on traffolyte labels.



C15.9 WIRES, CABLES AND FLEXIBLE CORDS

The type of insulation, number of cores, size of conductors and sheathing will be specified.

Control cabling shall not be installed in common containment with power wiring.

C15.10 P.V.C. AND V.R. INSULATED CABLES

Unarmoured P.V.C. and V.R. insulated cables shall be protected by conduit or trunking.

Conductors shall not be wrapped round stud terminals. Crimped lugs, applied with a tool specifically designed to prevent inadequate crimping, shall be used to connect cables to stud terminals. Care shall be taken to ensure that the cable insulation is not trimmed back beyond the lug.

C15.11 FLEXIBLE CORDS

Cables subjected to high temperatures shall be one of the following:-

1. Butyl in silicone rubber.
2. Mineral insulation.

Flexible cords shall be of the 300/300 volt grade or 300/500 volt grade to BS 6500, the type of insulation being suitable for the working temperature.

C15.12 WIRES AND CABLES

The following standards shall apply:-

BS 6004	P.V.C. insulated cables (non-armoured) for electric power and lighting.
BS 6007	Rubber insulated cables for electric power and lighting.
BS 6207	Mineral insulated cables Part 1 - copper conductors, copper sheathed. PVC orange covered.
BS 6231	P.V.C. insulated cables for switchgear and control gear wiring.
BS 6346	P.V.C. insulated cables for electricity supply.
BS 6480	Impregnated paper insulated cables for electricity supply Part 1 - lead or lead alloy sheathed cables for working voltages up to 33 kV.
BS 5467	XLFE insulated cables for electricity supply.
BS 6724	LSF insulated cables for electricity supply.
BS 5308	Twisted pair screened for control cables.

Note: The specification and installation of all equipment in other sections of this specification shall also apply to this section.



C15.13 PNEUMATIC INSTALLATIONS

1. General

Compressed air points shall be provided in the main high pressure compressed air system, and from these positions all pneumatic piping, hand valves, check valves, pressure reducing and filtering sets, and the like required for the complete pneumatic control installation shall be provided.

High pressure air pipework shall be in copper to BS EN 1057 R250, and low pressure piping in either copper to BS EN 1057 R220 or fire resistant plastic, all of sufficient size for the duties involved with a minimum size of 6mm O.D.

Pressure reducing and filtering set shall be complete with filters, reducing valves, high and low pressure gauges and provided for each control panel. Each pressure reducing and filtering set shall be complete with built-in safety pressure relief valves on the low pressure side and isolating valves on the inlet and outlet connections.

2. Installation

a) Plant Rooms

All pneumatic controllers, relays and other interlocking devices shall be mounted in purpose made lockable plant panels.

Where the panel is mounted adjacent to the plant being served all pneumatic piping shall be in copper tubing adequately clipped and supported to produce a neat and workmanlike appearance.

In cases when panels are not immediately adjacent to the plant, the air lines shall be run from the panel in fire resistant multicore plastic tubing to a convenient point adjacent to the plant. A junction box shall be used to change from the multicore plastic tube to copper tubing for all single line terminal connections.

Where supports are required for tubing either cable tray, perforated angle or conduit shall be used.

b) Floor Areas

Pneumatic piping in floor areas shall be either copper or fire resistant plastic clipped to the building fabric or supported by either trunking, cable tray or perforated angle.

Where pneumatic piping is run through structural members or in floor screeds, conduit sleeves shall be provided for protection and to enable the tubing to be removed if necessary.

c) Piping to Room Thermostats

i) Where thermostats are to be mounted on plaster walls the pneumatic air lines shall be either

Copper tubing buried direct in the plaster provided that there are no buried joints and that precautions are taken to ensure no chemical staining of the decorative finish occurs.

or



Plastic tubing through standard conduits embedded beneath the plaster to enable the tubing to be removed if necessary.

- ii) Where thermostats are to be mounted on fair face finishes the pneumatic air lines shall be surface mounted copper tubing clipped every 450mm.
- iii) Where thermostats are to be mounted on tiles, the pneumatic air lines shall be copper tubing buried beneath the rendering for the tiles.
- iv) Where thermostats are to be mounted on partitions or mullions the pneumatic air lines shall be fire resistant plastic tubing hidden within the panelling.

d) Fittings

Copper tube shall be jointed by means of compression or solder capillary fittings.

Plastic tube shall be jointed by either brass barb fittings or compression fittings with suitable tube wall support.

e) Commissioning and Testing

The Controls Engineer shall be responsible for the integrity of the entire pneumatic installation. All piping shall be pumped up to twice its working pressure and shown to maintain this pressure for a period of one hour.

C15.14 BUILDING MANAGEMENT SYSTEM

Each Building Management System shall follow BMS, rather than solid state technology. The generic term BMS shall be deemed to apply to all systems which operate on the basis of digital/analogue, inputs/outputs, utilise software control loops and personal computer 'front end' operator access (text or graphics).

C15.14.1 General

The Building Management System shall control, monitor and report on the electrical and mechanical services installation as detailed in Part D of the specification. This shall consist of software based system using central control workstations located in an agreed position(s) and remote stand alone outstations or combined with Motor Control Centre (MCC) panels within plant rooms.

A central user interface shall, where specified, be provided complete with a central processing unit (CPU) with multi modem capability, and colour monitor and printer. The user interface shall operate in a 'windows' environment to provide dynamic colour illustrations of all the various plantroom installations to give complete access to all controlled and monitored M & E equipment. All displayed information shall be displayed in real time.

All key functions, which due to failure would impair the safety of the services, shall have duplicate control strategy where standby equipment is provided and in any case would 'fail to safe' in the event of a complete systems failure.

In order to achieve a high degree of safety, multiple communication networks, field components and BMS hardware/software shall be provided. Failure of any one control function shall automatically result in a duplicate system maintaining control.



C15.14.2 Central Control Workstation

A Central Control Workstation shall be located in an agreed position.

Modem interrogation of the system shall be included together with all necessary software available to establish a modem linked compatible remote monitoring station. Where applicable existing BMS facilities which remain in any retained buildings shall be linked into the new BMS.

In the event of a mains failure the System Supervisor's workstation shall be supported for a minimum of 60 minutes duration from a local, plug-in uninterruptible power supply unit supplied as part of This Section of the Works, and this shall be in addition to any automatic supply from the standby generator.

All systems including networks and outstations shall be monitored for correct operation.

Each workstation shall have as a minimum requirement the following :-

1. Desktop or tower configuration.
2. IBM compatible/Intel Pentium.
3. Processor Unit :
 - 1 GHz
 - 128 Mbytes RAM
 - 30 Gigabyte Hard Disk
 - 1.4 Mbyte 3½" Floppy Disk Drive
 - 52 x Read/Write CD Rom Drive
 - Parallel Port
 - 2 No. Serial Ports
 - 1 No. Mouse Port / 1 No. Keyboard Port
 - 2 No. USB Ports
 - Modem Port
 - Graphics and Sound Cards
4. Mouse and QWERTY keyboard (101/102 enhanced).
5. Model V32 bis minimum.
6. 17" SVGA high resolution (800 x 600 pixels, 16 bit colour minimum) monitor.
7. Software; Windows XP, DOS Control System Manufacturer System Software.
8. Colour Laserjet Letter Quality Graphic Printer with A3 Sheet Feeder.

In the event of hardware or software failure the system shall provide audible and visual warning to the operators. Built-in self test and fault diagnosis programmes shall be incorporated into the system, and their use shall not impinge on the normal system operation.

The components of each workstation shall have high reliability and be suitable for long term operation in all expected operating environments.



C15.14.3 Workstation Software

The workstation software shall be generic and fully tested but specifically adapted for use on the project by the Controls Specialist. A Controls Specialist who is highly experienced both in the type of control system and also the operational characteristics of the type of project will be employed. The Specialist shall carry out a completely separate commissioning exercise and system analysis working from first principles up to final system verification.

The workstation software shall be based on an industry standard Window, Icon, Mouse pointer environment.

The system employed shall be 'user friendly' with a 'help' facility. Facilities shall also be provided for more experienced operators to enable them to use 'short cut' key entries to cut down the function access time on multiple operations.

Compatibility with industry standard disk operating system (DOS) shall be provided.

The software shall be suitable for event data logging and trend analysis for all functions at all times. Automatic down loading of events shall be incorporated and a suitable storage medium employed.

The software shall be complete with all necessary data manipulation and graphical reproduction software to enable easy analysis and report preparation.

Alarm conditions shall be easily discernible by screen graphical representations and shall be generated in bold character when printed.

The alarm priority levels shall be determined by the type of information and building area. Separate alarm conditions shall be expressed for, but not limited to :-

1. Fire alarm and associated plant override conditions.
2. Security breaches.
3. BMS communication and hardware failure.
4. Critical plant failure.
5. Electricity, Gas, Water failure.
6. Environmental condition alarms.
7. Non-critical plant failure.
8. Air systems failures.
9. Unacceptable room air pressure changes.
10. Low or high level water/oil storage system alarms.
11. Lift failures.

Override facilities shall be provided in order to distinguish between genuine plant failure and removal from service due to maintenance procedures etc.



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A system of hierarchical security access shall be employed at all user active points on the BMS system. The system employed shall prevent unauthorised personnel from exceeding their authorised operational responsibility level. Operator access logging shall be included.

The system software shall incorporate a full maintenance prompt programme whereby all items of plant are monitored for hours run usage. The system shall monitor fault regularity.

Trend logging shall be user selectable in order that a full system analysis can be undertaken over a realistic period. Continuous logging of energy usage, peaks and trends shall be incorporated into the system.

The software shall be written to accept an agreed level of additional function monitoring and control.

The graphic screen representation shall include mimic schematic diagrams showing system strategies with real time status indication of current operating conditions. The diagrams shall be easy to evaluate and maximum use shall be made of conventional system symbols for describing the operation sequence.

The screen generated text shall be in the English language with minimal abbreviations.

A comprehensive labelling system shall be employed throughout the site and the references used for labelling shall appear on the graphical scheme representation. The screen referencing shall be removable in order to achieve a clearer display of schematic arrangements. Mnemonic nomenclature shall be agreed with the Engineer.

The software written for the project shall be translated into the English language in the form of flow diagrams and supportive text, initially to demonstrate design intent compliance, and ultimately to form part of the O & M documentation.

This documentation shall be submitted prior to loading the software. The software structure shall be written in discrete inter-linked packages with the intention that modifications and additions can be made by the Client after project handover. The software shall be rigorously tested off site to the satisfaction of the Services Engineer and mock-up simulations provided, if requested, to guarantee system compatibility and reliability. All necessary temporary on-site or off site equipment shall be provided to demonstrate confidence in the system.

C15.14.4 Outstations

Each outstation connected to the BMS communications network shall be used to locally monitor and control the various systems and communicate with other components on the network.

Outstation digital and analogue inputs and outputs shall receive and initiate control systems from all plant and support systems. Volt free contacts employed to initiate plant conditions shall employ hardware and software 'de-bounce' and electrical noise limiting. Special attention shall be given to ensure that all inputs to the outstations are 'noise' free.

Each outstation shall be complete with 10% of spare space 'points' capacity in order to accommodate additional future input and output facilities.

Standard analogue inputs shall be adopted using 0-10 volt or 4-20 mA signalling. Analogue to digital conversion shall be at least 12 bit resolution.



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Real time clock synchronisation with the central control system shall be monitored and have independent battery back-up facilities.

Compatible pulsed output energy consumption metering shall be connected to the system, where specified.

Each outstation shall be self sufficient or 'intelligent', capable of maintaining system operation during communication breakdowns or returning all systems within their control to a safe condition.

Outstation software shall be accessed from the central workstation(s), or using a portable computer and suitable access port. Software access shall be 'user friendly' but only at the required security access level.

Each outstation shall be located within a control or MCC panel or be locally mounted where additional outstations are required to minimise field wiring.

C15.14.5 MCC & Outstation Panels

All MCC and outstation panels shall as a minimum be constructed to IP54.

Each item of equipment shall be suitable for operating in the environment it is positioned in, and operate satisfactorily in the ambient temperature and humidity variations possible at each locality.

Each panel terminal shall be secured to the backplate using DIN rail.

Where two or more voltage levels exist in the same panel, separate terminal rails shall be used for each voltage. A suitable warning label stating the voltage levels shall be supplied and fixed on or adjacent to the relevant terminals.

All exposed terminals of equipment items having a potential greater than 50 volts to earth and which are readily accessible when the panel door is opened shall be shrouded. This will apply especially to door mounted equipment.

A minimum of 25% spare capacity for each voltage range shall be provided on terminal blocks.

Control and indication wiring between fixed portions and hinged doors shall be protected against abrasion or entrapment by enclosure in a flexible PVC tube or duct, which will be attached to one end to the fixed portion and at the other end to the door.

Wiring passing through holes in the panel shall be fully protected by correctly fitting grommets or bushes. Wiring shall not be carried over or bent around sharp edges. All cables and wires shall be fitted with suitable crimped connectors and be identified at each end using slip-on colour coded type markers. The numbering shall be in accordance with British Standards and all wire and terminal numbers shall agree.

Intrinsically safe cabling shall be coloured blue and installed in accordance with British Standards.

Duty and identification labels shall be 'Traffolyte' type with black letters on a white background. All panels shall have a label indicating the highest voltage present, permanently fixed using screws or rivets. Adhesive shall not be used.



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Danger or warning labels shall be 'Traffolyte' type with red letters on a white background. Yellow danger flashes may be thin film.

All equipment shall be provided with a main duty label. Relays or contactors shall be labelled with 'Traffolyte' type labels. Each label shall be positioned such that it is always attached to or adjacent to the fixed portion of a device such as the base of a plug in relay.

Panel units shall be provided with a main duty label in letters approximately 10mm high and be fixed by means of screws not adhesive.

Panels containing supplies from multiple sources shall be arranged to be completely isolated on operation of the Mains Panel Isolator. All wiring within the control system and panels shall be of low smoke grade.

Panels which have equipment mounted on the floor shall have a flexible earth strap, protected to prevent abrasion or entrapment, provided to ensure continuity. The earth strap shall be firmly fixed to non-removable parts of the door and panel.

Removable full width and depth undrilled gland plates adequately sized shall be provided to each panel.

Unless otherwise specified all cabling shall enter from above. Each gland plate shall be located in such a manner that ample space is available for glanding off and terminating all cables.

HRC fuses of suitable rating shall be provided with fuse bases and carriers being fully insulated. At least two spare fuses of each rating shall be left within each panel.

Each fuse for control circuits which are fed from a power circuit within the panel shall be GEC/EE type NIT. Each fuse shall be located as near to the main power circuits as possible.

Isolators for power circuits shall be adequately rated for their duty and be equipped with facilities for padlocking in the OFF position. Each isolator shall be interlocked with the control panel doors.

Isolators for power circuits shall be completely segregated from each other and from other equipment by metal partitions. Isolators for control circuits shall be of the rotary switch type suitably rated for the duty. Each switch shall be capable of being padlocked in the OFF position with rotary switch contacts and terminals being completely shrouded, the shrouding taking the form of a removable bolted cover.

All motor starters shall be provided with hand/off/auto switches located on the fascia panel.

Incorrect manual operation of any motor switch shall not result in hazardous consequences via the BMS and hardwired interlocking systems.

All motor starters shall be monitored by the BMS for auto control selection, run, tripped and failed conditions. In addition, flow switches connected to the BMS shall confirm system operation. System initiation signals will not be used to determine plant status.



C15.15 TESTING & COMMISSIONING

The whole of the Automatic Controls installation shall be tested and commissioned by the Controls Engineer, to the entire satisfaction of the Services Engineer.

C15.16 METHOD OF CONTROL

For specific project details refer to Part D of this specification (Schedule of Technical Requirements).



PART C - SECTION 16 ELECTRICAL

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PART C - SECTION 16

ELECTRICAL

C16.1 GENERAL

Electrical equipment shall comply in all respects with the relevant British Standard Specification, the Regulations for Electrical Installations issued by the Institution of Electrical Engineers (BS 7671:2008) and all other Statutory Regulations.

Full information, i.e. wiring diagrams, motor capacity, and the like shall be provided to enable each item of equipment to be correctly wired up and the correct operation of the various complete installations to be achieved.

C16.2 ELECTRICAL SUPPLY

The electrical supply shall be 400 volts, 3 phase, 50 Hz, or 230 volts, single phase, 50 Hz.

C16.3 EARTHING

Each control panel or item of electrical equipment shall be bonded to earth in accordance with BS 7671:2008 and BS 7430.

C16.4 ELECTRIC MOTORS

All electric motors shall be 'Super Silent' totally enclosed fan cooled with Class E insulation. Wherever possible, horizontal foot mounting machines shall be used with standard dimensions.

All electric motors that form part of the Works shall be sized in accordance with the Equipment Selection clause contained within Part B of this specification.

Motors up to and including 375W shall be single phase and above 375W, 3 phase. Motors up to and including 3.7 kW shall be suitable for direct-on-line starting and above 3.7 kW star delta.

Motors shall have a maximum speed of 1500 r.p.m.

Motors shall be capable of frequent starting in either direction with reversing duty as required. The driving and non-driving ends shall be fitted with extended grease cups.

Standard shaft extensions shall be used wherever possible with parallel keys. Terminals shall be arranged in enclosures capable of being rotated to any of four positions at 90° intervals and suitable for direct-on-line starting or assisted starting.

A Schedule of Motors shall be supplied giving the following particulars for each motor:-

1. Duty.
2. Horse Power.
3. Number of phases.



4. Full load current.
5. Starting current.
6. Speed.
7. Full details of any characteristics which require special starting or running facilities.

C16.5 MOTOR CONTROL GEAR

All motors shall be supplied complete with an automatic starter. Except where included in Control Panels, automatic starters shall be supplied loose for individual fixing.

Motor control gear shall be fitted in dust and damp-proof enclosures and all motors shall be protected by contactors with overload, no volt and single phase releases and integral isolators of the correct rating. Motor control gear shall be suitable for controlling up to 15% over the rating of the installed motor. Final setpoints of the overloads shall be suitable for the full load current when a particular system is commissioned.

Motor starters and contactors shall be manufactured in accordance with BS EN 60947-4-1 and BS 5856 : Part 1. All contactors, switches and relays shall be of approved heavy duty capable of operating on the heavy duty caused by frequent starting with a minimum of attention.

C16.6 NON STANDARD EQUIPMENT

The requirements of this section shall apply to all equipment specified unless otherwise stated. Manufacturers shall be informed of these requirements where they do not form part of their standard product.

C16.7 ARMOURED PVC INSULATED CABLE INSTALLATIONS

General

P.V.C. - insulated armoured cables shall comply with BS 6346 shaped cores with the neutral core of the same cross section as the phase cores unless otherwise specified. Conductors shall be copper stranded, aluminium stranded or solid aluminium as specified and be P.V.C. - insulated, filled, P.V.C. - sheathed, single wire armoured and P.V.C. - sheathed overall 600/1000 volt grade. Solid aluminium conductor cables may be armoured with aluminium strip providing there is adequate conductivity when it is used as an earth return path.

Routing

Cables shall be run between termination points in continuous lengths. Joints will not be allowed unless specified or approved.

All low voltage cables laid direct in the ground shall be laid at a depth of 600mm and blinded with a radial thickness of at least 100mm of sand.

The presence of underground cables shall be indicated by marker tapes laid directly above the cables after the trench has been backfilled, the tapes being approximately 300mm below the surface level. The tapes shall be manufactured from high grade polythene 150mm wide by 0.1mm gauge, coloured yellow with the words "electric cable below" along its length.



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Cables which follow the same route and are laid in the ground shall be in horizontal formation with spacing between cables where possible of not less than 150mm with the exception of single-core cables which shall be run in trefoil formation and touching along their entire length. Each group of cables shall be indicated by separate marker tapes.

Adequate cable markers of approved design shall be used to indicate the route of buried cables at intervals of not more than 75 metres and at points where change of direction occurs. Where markers are of a free-standing post type, they shall be not less than 150mm wide x 800mm high x 75mm thick, be indelibly marked 'Electrical Cable' and 300mm shall be exposed above ground.

The cables shall be marked at each end and at access points by a label indicating the cable size and circuit.

Cables under roads and rail crossings shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm, have bends to suit the cables and extend 1m on either side of the road or rail crossing.

Cables under floors or through walls shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm and the bends to suit the cables.

Cable conduits and ducts which terminate in buildings shall be sealed with a permanently plastic weather-proof sealing compound in conjunction with hardwood bushes to prevent the ingress of water, foreign matter and vermin. Any spare conduits and ducts shall be similarly sealed.

Cables shall be installed only when both the cable and ambient temperature are at or above a temperature of 5°C and have been so kept for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature to avoid risk of damage during handling.

Unless otherwise specified, cables run in air, including engineering service ducts, shall be fixed with aluminium alloy or approved non-inflammable claw cleats with galvanised back-straps using galvanised bolts conforming to BS 4190 with maximum spacing between supports as detailed in Section 522-08 BS 7671:2008. Cleats for cables up to and including 50mm dia. shall be fixed by a single bolt and above 50mm dia. by 2 bolts. The correct size of cleat fixing stud shall be provided to suit the cable size to ensure that the stud does not extend appreciably beyond the tightened nut. Excess pressure of cleats on P.V.C. - insulated cables shall be avoided to prevent deformation of the plastic sheathing. Suitable supporting steelwork and/or galvanised cable tray shall be provided where cables cross open spaces. Such steelwork shall be protected by a rust inhibiting paint.

Installation Radii

Cables shall not be bent during installation to a smaller radii than 8 x dia. of cable.

Jointing and Terminating

a) General

The jointing and terminating of all cables shall be performed by an experienced cable jointer trained and fully conversant with modern techniques and once the cable is cut for the purpose of making a joint or termination the work involved shall be completed without interruption; if for any reason the work cannot be completed then the cable ends shall be sealed immediately with P.V.C. tape.



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All cable joints and terminations shall be supplied except the termination to the Supply Authority's service cable box. All switchgear supplied by others will be complete with cable boxes but not terminating materials.

All joints shall be made in cast iron or moulded plastic boxes purpose made for PVC/SWA/PVC sheathed cables, the joints being wrapped with P.V.C. tape to give a degree of insulation at least equal to that of the original insulation, and the boxes filled with an approved compound.

Where cables are terminated outside buildings or in damp situations compound filled boxes shall be used.

Particular attention shall be paid to ensure earth continuity of the cable armouring, cast iron boxes being provided with armour clamps and moulded plastic boxes with armour clamps and a copper strip. After completion of the joints, cast iron boxes shall be painted with two coats of bitumastic paint.

The cores of medium voltage cables shall be jointed colour-to-colour or colour-to-number as appropriate. Cores which are identified by numbers shall be connected so that:

- 0 is neutral in any multi-core cable
- 1 is red phase in a 3- or 4- core cable or the phase conductor in a 2- core cable
- 2 is yellow phase in a 3- or 4- core cable
- 3 is a blue phase in a 3- or 4- core cable

b) P.V.C. - insulated aluminium armoured P.V.C. - sheathed cables with solid aluminium conductors.

Joints shall be of the indented compression type made by means of a hydraulic compression ramhead and suitable compression dies according to the core size of the cable, with strict adherence to the cable manufacturer's recommendations on accessories, ferrules, compression pressures and jointing techniques.

Terminations shall be made using the indented compression method with sockets of soft aluminium shaped to match the profile of the conductor core. Suitable approved aluminium cable glands with earth tag washers shall be used and the glands protected with P.V.C. shrouds. Clamps around the armour for earth bonding will not be accepted.

All metal to metal contacts at termination points, gland to armour contacts and dissimilar metal contacts shall be smeared with an approved grease.

c) P.V.C. - insulated armoured P.V.C. - sheathed cables with stranded copper or aluminium conductors.

Joints shall be of the compression type as for solid aluminium conductors or of the sweated type using a ferrule of not less than the cross-sectional area of the conductor for which it is to be used. Only tinned aluminium ferrules shall be used with aluminium conductors.

Terminations shall be of the compression type as for solid aluminium conductors or of the sweated type using a lug, suitable for the conductor size. Cable armour shall be neatly arranged and clamped to a suitable gland, the gland being protected with a P.V.C. shroud.



C16.8 CROSS-LINKED POLYETHYLENE INSULATED CABLE INSTALLATIONS

General

Armoured cross-linked polyethylene (XLPE) insulated cables shall be manufactured in accordance with BS 5467.

Un-armoured cross-linked polyethylene insulated cables shall be manufactured in accordance with I.E.C.502.

Conductors shall be high conductivity annealed copper or high purity aluminium, as specified, and shall be in accordance with BS 6360.

Copper conductors shall be stranded circular and compacted for single core cables, and shaped stranded for multi-core cables. Aluminium conductors shall be stranded circular and compacted for single core cables, and shaped solid for multi-core cables.

The neutral conductor shall be of the same cross-section as the phase conductor unless otherwise specified.

All cables shall be XLPE insulated, PVC bedded, galvanised steel wire armoured, PVC sheath overall and 600/1000 volt grade.

A separator of PETP (polyethylene terephthalate) or polypropylene film shall be applied between the XLPE insulation and the PVC bedding.

If armoured single core cable is specified, the armour shall be non-magnetic (i.e. aluminium wire or strip).

The outer sheath of 6,350/11,000 volt grade cable shall be coloured "red".

Core Identification

Each conductor core insulation shall be identified by numbers, or by colours, at the option of the manufacturer, in accordance with the following sequence:

Number of Cores	Numbers	Colours
Single		Black
Two	0, 1	Black, Red
Three	1, 2, 3	Red, Yellow, Blue
Four	0, 1, 2, 3	Black, Red, Yellow, Blue

The number '0' or the colour 'Black' is intended to indicate the neutral conductor of a multi-core cable.

Routing

Cables shall be run between termination points in continuous lengths. Joints will not be allowed unless specified or approved.



All low voltage cables laid direct in the ground shall be laid at a depth of 600mm and blinded with a radial thickness of at least 100mm of sand. All high voltage cables shall be laid in a similar manner but at a depth of 900mm. The presence of underground cables shall be indicated by marker tapes laid directly above the cables after the trench has been backfilled, the tapes being approximately 300mm below the surface level. The tapes shall be manufactured from high grade polythene 150mm wide by 0.1mm gauge, coloured yellow with the words "electric cable below" along its length.

Cables which follow the same route and are laid in the ground shall be in horizontal formation with spacing between cables where possible of not less than 150mm with the exception of single-core cables which shall be run in trefoil formation and touching along their entire length. Each group of cables shall be indicated by separate marker tapes.

Adequate cable markers of approved design shall be used to indicate the route of buried cables at intervals of not more than 75 metres and at points where change of direction occurs. Where markers are of a free-standing post type, they shall be not less than 150mm wide x 800mm high x 75mm thick, be indelibly marked 'Electrical Cable' and 300mm shall be exposed above ground.

The cables shall be marked at each end and at access points by a label indicating the cable size and circuit.

Cables under roads and rail crossings shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm, have bends to suit the cables and extend 1m on either side of the road or rail crossing.

Cables under floors or through walls shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm and the bends to suit the cables.

Cable conduits and ducts which terminate in buildings shall be sealed with a permanently plastic weather-proof sealing compound in conjunction with hardwood bushes to prevent the ingress of water, foreign matter and vermin. Any spare conduits and ducts shall be similarly sealed.

Cables shall be installed only when both the cable and ambient temperature are at or above a temperature of 5°C and have been so kept for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature to avoid risk of damage during handling.

Unless otherwise specified, cables run in air, including engineering service ducts, shall be fixed with aluminium alloy or approved non-inflammable claw cleats with galvanised back-straps using galvanised bolts conforming to BS 4190 with maximum spacing between supports as detailed in Section 522-08 of BS 7671:2008. Cleats for cables up to and including 50mm dia. shall be fixed by a single bolt and above 50mm dia. by 2 bolts. The correct size of cleat fixing stud shall be provided to suit the cable size to ensure that the stud does not extend appreciably beyond the tightened nut. Excess pressure of cleats on P.V.C. - insulated cables shall be avoided to prevent deformation of the plastic sheathing. Suitable supporting steelwork and/or galvanised cable tray shall be provided where cables cross open spaces. Such steelwork shall be protected by a rust inhibiting paint.

Installation Bending Radius

Cables shall not be bent during installation to a radius smaller than 8 times the overall diameter of the cable.



Jointing and Terminating

a) General

The jointing and terminating of all cables shall be performed by an experienced cable jointer trained and fully conversant with modern techniques and once the cable is cut for the purpose of making a joint or termination the work involved shall be completed without interruption; if for any reason the work cannot be completed then the cable ends shall be sealed immediately with P.V.C. tape.

All cable joints and terminations shall be supplied except the termination to the Supply Authority's service cable box. All switchgear supplied by others will be complete with cable boxes but not terminating materials.

All joints shall be made in cast iron or moulded plastic boxes, purpose made for XLPE/PVC/SWA/PVC sheathed cables. All joints shall be selected from the cable manufacturer's selection chart suitable for the size of cable and type of joint required. The complete jointing technique shall be carried out strictly in accordance with the manufacturer's recommendations, and particular attention should be paid to the installation of earth bonding clamps in joints and terminations, to ensure that each armour wire or strip contributes equally to the conductance of the bonding connection, and that the resistance across a connector is not higher than that of the equivalent length of connected armour of the cable.

Where cables are terminated outside buildings or in damp situations compound filled boxes shall be used.

Particular attention shall be paid to ensure earth continuity of the cable armouring, cast iron boxes being provided with armour clamps and moulded plastic boxes with armour clamps and a copper strip. After completion of the joints, cast iron boxes shall be painted with two coats of bitumastic paint.

b) XLPE Insulated, Armoured, PVC Sheathed Cable with Copper Conductors

Joints shall be of the indented compression type made by means of a hydraulic compression ramhead and suitable compression dies according to the core size of the cable, with strict adherence to the cable manufacturer's recommendations on accessories, ferrules, compression pressures and jointing techniques.

Terminations shall be made using the indented compression method with sockets of soft tinned copper, shaped to match the profile of the conductor core. Suitable approved aluminium cable glands with earth tag washers shall be used and the glands protected with PVC shrouds. Clamps around the armour for earth bonding will not be accepted.

All metal to metal contacts at termination points, gland to armour contacts and dissimilar metal contacts shall be smeared with an approved grease.

c) Cable Glands

All cable glands for terminations shall be manufactured in brass or aluminium as applicable, and shall be in accordance with BS 6121. All glands shall be provided with locknuts, earth tags and PVC shrouds.

d) Through Joints

Through joints shall not be allowed in any cables without prior written approval from the Services Engineers.



C16.9 LOW SMOKE AND FUME (LSF) CABLES

General

Low smoke and fume (LSF) cables shall be manufactured from materials which have been tested in accordance with:

I.E.C. Publication 754 : Part 1.

BS ISO 4589 : Part 2

BS 6746.

I.E.C. Publication 229.

Health & Safety Executive Guidance Note on Threshold Limit Values.

Core Identification

Each conductor core insulation shall be identified by numbers, or by colours, at the option of the manufacturer, in accordance with the following sequence:-

<u>Number of Cores</u>	<u>Numbers</u>	<u>Colours</u>
Single		Black
Two	0, 1	Black, Red
Three	1, 2, 3	Red, Yellow, Blue
Four	0, 1, 2, 3	Black, Red, Yellow, Blue

The number '0' or the colour 'Black' is intended to indicate the neutral conductor of a multi-core cable.

Routing

Cables shall be run between termination points in continuous lengths. Joints will not be allowed unless specified or approved.

All low voltage cables laid direct in the ground shall be laid at a depth of 600mm and blinded with a radial thickness of at least 100mm of sand. The presence of underground cables shall be indicated by marker tapes laid directly above the cables after the trench has been backfilled, the tapes being approximately 300mm below the surface level.

The tapes shall be manufactured from high grade polythene 150mm wide by 0.1mm gauge, coloured yellow with the words "electric cable below" along its length. Concrete interlocking cable tiles shall be installed to cover all mains and sub-mains distribution cables laid in the ground.

Cables which follow the same route and are laid in the ground shall be in horizontal formation with spacing between cables where possible of not less than 150mm with the exception of single-core cables which shall be run in Trefoil formation, with each trefoil group separated by a minimum distance of 300mm. Neutral cables shall be laid between Trefoil groups. Each group of cables shall be indicated by separate marker tapes.



The cables shall be marked at each end and at access points by a label indicating the cable size and circuit.

Cables under roads shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm, have bends to suit the cables and extend 1m on either side of the road.

Cables under floors or through walls shall be run in conduits of either vitrified clay having a plastic sleeve to form a push fit joint, or pitch fibre. The conduits shall have a minimum diameter of 100mm and the bends to suit the cables.

Cable conduits and ducts which terminate in buildings shall be sealed with a permanently plastic weather-proof sealing compound in conjunction with hardwood bushes to prevent the ingress of water, foreign matter and vermin. Any spare conduits and ducts shall be similarly sealed.

Cables shall be installed only when both the cable and ambient temperature are at or above a temperature of 5°C and have been so kept for the previous 24 hours, or when special precautions have been taken to maintain the cable at or above this temperature to avoid risk of damage during handling.

Unless otherwise specified, cables run in air, including engineering service ducts, shall be fixed with aluminium alloy or approved non-inflammable claw cleats with galvanised back-straps using galvanised bolts conforming to BS 4190 with spacing between supports to comply with BS 7671:2008 and the manufacturer's recommendations. Cleats for cables up to and including 50mm dia. shall be fixed by a single bolt and above 50mm dia. by 2 bolts.

The correct size of cleat fixing stud shall be provided to suit the cable size to ensure that the stud does not extend appreciably beyond the tightened nut. Excess pressure of cleats on P.V.C. - insulated cables shall be avoided to prevent deformation of the plastic sheathing. Suitable supporting steelwork and/or galvanised cable tray shall be provided where cables cross open spaces. Such steelwork shall be protected by a rust inhibiting paint.

Installation Bending Radius

Cables shall not be bent during installation to a radius smaller than 8 times the overall diameter of the cable.

Jointing and Terminating

a) General

The jointing and terminating of all cables shall be performed by an experienced cable jointer trained and fully conversant with modern techniques and once the cable is cut for the purpose of making a joint or termination the work involved shall be completed without interruption; if for any reason the work cannot be completed then the cable ends shall be sealed immediately with P.V.C. tape.

All cable joints and terminations shall be supplied except the termination to the Supply Authority's service cable box. All switchgear supplied by others will be complete with cable boxes but not terminating materials.



All joints shall be made in cast iron or moulded plastic boxes, purpose made for XLPE/LSF/SWA/LSF sheathed cables. All joints shall be selected from the cable manufacturer's selection chart suitable for the size of cable and type of joint required. The complete jointing technique shall be carried out strictly in accordance with the manufacturer's recommendations, and particular attention should be paid to the installation of all bonding clamps in joints and terminations, to ensure that each armour wire or strip contributes equally to the conductance of the bonding connection, and that the resistance across a connector is not higher than that of the equivalent length of connected armour of the cable.

Where cables are terminated outside buildings or in damp situations compound filled boxes shall be used.

Particular attention shall be paid to ensure earth continuity of the cable armouring, cast iron boxes being provided with armour clamps and moulded plastic boxes with armour clamps and a copper strip. After completion of the joints, cast iron boxes shall be painted with two coats of bitumastic paint.

b) XLPE Insulated, Armoured, LSF Sheathed Cable with Copper Conductors

Joints shall be of the indented compression type made by means of a hydraulic compression ramhead and suitable compression dies according to the core size of the cable, with strict adherence to the cable manufacturer's recommendations on accessories, ferrules, compression pressures and jointing techniques.

Terminations shall be made using the indented compression method with sockets of soft tinned copper shaped to match the profile of the conductor core.

Suitable approved brass cable glands with earth tag washers shall be used and the glands protected with PVC shrouds. Clamps around the armour for earth bonding will not be accepted.

All metal to metal contacts at termination points, gland to armour contacts and dissimilar metal contacts shall be smeared with an approved grease.

c) Cable Glands

All cable glands for terminations shall be manufactured in brass and shall be in accordance with BS 6121. All glands shall be provided with locknuts, earth tags and PVC shrouds.

Single Core Cables

Single core cables shall be 450/750 volt rated and shall have copper conductor insulated with a cross linked LSF material.

The cables shall comply in full with BS 7211, be flame retardant to BS 4066 : Part 1, I.E.C. 332.1, BS 4066 : Part 2, I.E.C. 332-2, and comply, when tested, to BS 6425 : Part 1 and I.E.C. 754 : Part 1.

Single core, armoured cables shall have aluminium wire armour and conform to the same standards as multi-core armoured cables.

Multi-Core Cables

Multi-core cables shall be 600/1000 volt rated and shall be XLPE insulated, LSF compound bedded, galvanised steel single wire armoured or un-armoured as required, and LSF compound sheathed to comply fully with BS 6724.



LSF sheathed, armoured cables shall show compliance with BS 4066 : Part 1 and I.E.C. 332-1 when tested under fire conditions, and also with NMV 1.5 of BS 4066 : Part 3 and I.E.C. 332-3 Category C.

C16.10 MINERAL INSULATED METAL SHEATHED WIRING INSTALLATIONS

General

Unless otherwise specified or approved M.I.M.S. cables shall have copper conductors and copper outer sheath and comply with BS 6207.

Cables shall be 1000V Class, except for single phase sub-circuits when the 600V Class may be used.

Cables having a conductor size of less than 1.5mm.sq. section shall not be used unless specifically mentioned in the Schedules or shown on the drawings.

Where mineral insulated metal sheathed cables are specified as having a protective covering of low smoke and fume (LSF) material, the covering shall comply with BS 6724.

Where specified, voltage surge suppressors shall be fitted to small three phase star-connected motors and contactor coils as recommended by the cable manufacturer.

Installation

Cables shall be run at least 150mm clear of all plumbing and mechanical services.

In non-corrosive and dry situations copper sheathed cables shall be unsheathed providing they do not touch asphalt, stone, barium or aluminium.

In damp and corrosive situations such as buried runs, boiler houses, wet areas, service ducts and external runs, cables shall be P.V.C. or LSF sheathed and have terminations covered with P.V.C. or LSF shrouds. If the buried length is short, plain copper sheathed cables double lapped with adhesive P.V.C. tape may be used if approved.

Aluminium sheathed cable shall be P.V.C. or LSF sheathed wherever they are specified.

Unsheathed copper cables shall be secured along the entire length to walls with copper clips or saddles fixed with brass screws (see table below). P.V.C. and LSF sheathed cables shall be secured with P.V.C. covered clips or saddles fixed with brass screws to wall or cable tray along their entire length (see table below). When 3 or more cables are run together multiple saddles shall be used and the cables supported on cable trays. Securing clips and saddles shall be spaced as follows:-

Overall diameter of Cable - mm	Maximum spacing of fixings - mm	
	Horizontal	Vertical
Not more than 9	600	800
Above 9 but not more than 15	900	1200
Above 15 but not more than 20	1500	2000



Cable trays shall be used to support cables where multiple runs occur in plant rooms, roof and floor spaces, ducts and crawlways. Cable trays shall be of the galvanised or P.V.C. coated type, except that in dry non-corrosive situations the tray can be of the painted type. Bitumastic based paints shall not be used where cables are of the served type. Galvanised cable trays shall not be used for cables having bare copper sheaths.

Cables installed in ceiling or floor spaces shall be run parallel to, or at right angles to, supporting beams or joints.

Spacing of supports shall be in accordance with Section 522-08 of BS 7671:2008. Cables buried in plaster shall be run only in vertical and horizontal directions.

Where cables pass through floors or walls, they shall be protected by earthenware, P.V.C. or metal sleeves.

Cables emerging from the ground or from the floor shall be adequately guarded from mechanical damage up to a height of 2m by heavy gauge galvanised conduit or channel. The conduit or channel shall project into the floor or duct space and be suitably bushed at each end. The sheaths of unserved cables shall be bonded to the guard.

Where cables are installed in narrow ducts, the cables may be laid on the bottom of the duct. When the duct width exceeds 300mm, cables shall be firmly fixed direct to the duct walls or to tray plate.

Cables buried direct in the ground shall be laid at a depth of 600mm and blinded with a radial thickness of at least 100mm of sand. The presence of underground cables shall be indicated by marker tapes laid directly above the cables after the trench has been backfilled, the tapes being approximately 300mm below the surface level.

The tapes shall be manufactured from high grade polythene 150mm wide by 0.1mm gauge, coloured yellow with the words 'Electric Cable Below' printed along its length. Where a subsidence is likely to occur the cables shall be installed in the ground by snaking.

At building expansion joints a cable loop shall be provided.

Where connections are made to motors and other plant where vibration or expansion is likely to occur, the cable shall be terminated in an approved connecting box and flexible P.V.C. insulated (or specified) connections taken in flexible metallic conduit to the equipment, alternatively the M.I.M.S. cables shall be terminated direct to the motor connection boxes by forming a loop of cable of minimum diameter 150mm to minimise vibration of the M.I.M.S. cable.

Jointing Terminating and Accessories

i) General

Cable glands shall be supplied for connection to all apparatus required to be connected whether or not the apparatus was supplied by others.

Terminations shall be made using a seal rated to suit the application, the tails being insulated with neoprene or P.V.C. coloured sleeves identified in accordance with Table 51A of BS 7671:2008. Before filling a pot seal, care shall be taken to ensure that it is dry and free from all traces of metal filings. Lug type cone grip sockets or approved crimp lugs shall be used for cables larger than 2.5 sq.mm. which are connected to studs or pillar terminals. Conductors 16 sq.mm. and above shall be terminated with lug type cone grip sockets.



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Ring-type universal glands shall be employed to house the seals and shall be of approved design and of the correct size to suit the cable. Any serving removed for the purpose of making off the gland shall be replaced with P.V.C. tape and the whole gland assembly protected with a P.V.C. shroud.

Connecting boxes shall be accessible and of adequate capacity to prevent congestion. The terminals shall be in insulating connecting blocks with brass connections of adequate size and current rating for the cable size specified. Terminal blocks shall be fixed to the base of the box.

Straight-through joints shall be made using only the cable manufacturer's accessories and connections may be either soldered or crimped.

Crimping shall be performed with a tool which prevents inadequate crimping. Buried joints or joints in corrosive situations shall be protected with layers of self-amalgamating P.V.C. tape, or in epoxy resin cases.

Where cables are to be concealed in plastered walls terminations shall be made using cold seals having earth leads incorporated. The earth lead shall be insulated by neoprene or P.V.C. sleeving and shall terminate in the junction box at a 5mm tapped screw inside the box.

ii) Aluminium Sheathed Cables

Any tools used for installing aluminium cables shall be cleaned prior to using, especially if they have been used on copper cables.

All glands shall be manufactured from plastic material, earth continuity being maintained by an earth tail in electrical contact with the cable sheath via the cable seal.

Aluminium conductors shall be lightly smeared with an approved grease before connections are made.

C16.11 PVC INSULATED AND PVC SHEATHED WIRING INSTALLATIONS

General

P.V.C. insulated and P.V.C. sheathed wiring installations shall be used only where particularly specified.

Cables

Cables shall be either flat twin with earth continuity conductor or flat three core with earth continuity conductor manufactured in accordance with BS 6004. The colours for core identification shall be red and black for twin core and red, yellow and blue for three core. Cables having a conductor size of less than 1.5mm² section shall not be used unless specifically mentioned in the Schedules or shown on the drawings. Cables above 2.5mm. sq. shall be stranded type.

Accessories

All surface accessories shall be of the all-insulated pattern.

Lighting ceiling roses shall be of the three terminal pattern incorporating an earth terminal. The 'live' terminal shall be shrouded.



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Joint and junction boxes shall comply with BS 6220. Connectors shall have metal screws or pinch plate: porcelain cone connectors will not be permitted.

Metal boxes, which may be used for flush accessories, shall be fitted with suitable grip adapters for cables which are not protected by steel conduit.

Installation

The cables generally shall be concealed wherever possible within ceilings, walls and roof spaces. No unnecessary joints shall be made in runs of cables without approval.

In roof spaces which are accessible through trap doors, the cables shall be clipped to the side of joists. Where cables traverse the joists they shall be protected from mechanical damage.

In ceiling spaces not less than 300mm deep cables may be supported by approved hangers. Multi-cable runs may be bunched in groups of six. Where it is necessary to cross the joists at right angles, the cables may be fixed directly to the under-side of the joists.

Cables shall not be run in unsupported spans between beams or beams and trusses. In ceiling spaces less than 300mm deep or where a ceiling is fixed directly onto battens, the cables shall be fixed to the structural ceiling. Where cables cross battens the batten shall be notched in such a position that the cable will not be liable to damage.

When a ceiling is fixed directly to joists the cable shall be secured to the sides of the joists. Where cables cross joists, holes shall be drilled through the joists. These holes shall be as near as possible to the neutral axis of the joist and the joist support.

Where horizontal surface cable runs are necessary they shall be kept at high level and be fixed on the wall within 50mm from the ceiling. Cables passing through walls shall be protected by short lengths of steel or P.V.C. conduit. Cable below a height of 1400mm from floor level shall be protected with heavy gauge welded conduit.

Cables shall be fixed by means of approved nylon clips, tinned brass saddles or approved plastic coated saddles or clips. Multi-cable runs shall be held in position by a common strip saddle or clip. The spacing of clips on cables which are installed in accessible positions shall be as set out in Section 522-08 of BS 7671:2008. Cables which are installed in vertical runs which are inaccessible and unlikely to be disturbed shall be supported at the top of the run by a clip and rounded support of a radius not less than the appropriate value stated in Table 52C of the BS 7671:2008.

Cables concealed in wall finishes shall be protected throughout their entire concealed length by galvanised channel or steel conduit fixed at both ends and at least one intermediate position. The channel and conduit shall project at least 50mm into the roof space or floor void. Channel and conduit buried in plaster shall be installed so as to allow a minimum depth of plaster of 5mm over its entire length.

Cables concealed in concrete floors shall be protected throughout their entire concealed length by means of heavy gauge welded conduit. The conduit shall have at least 35mm depth of concrete cover over its entire length.

End of conduits shall be so finished as to prevent abrasion of the cable insulation when cables are being drawn into or out of the conduits or connected to apparatus. Bushes for use with conduits may be rubber, P.V.C. or brass.



Joint and junction boxes will not be permitted in hidden or inaccessible positions and those in damp situations shall be moisture-proof and filled with an approved proprietary plastic sealing compound. The boxes shall be securely fixed to the building structure by means of two or more screws and their positions clearly marked on the record drawings.

At every lighting point the cable shall be terminated within a BS 31 steel or P.V.C. box with cable clamps and the box securely fixed to the structure. P.V.C. boxes shall be fitted with steel support inserts with the inserts securely fixed to the structure. The lighting points shall be wired by the 'loop-in' method, the live, neutral and earth wires being taken to every point.

All metalwork such as switch boxes, channels, conduits, conduit boxes and metal light fittings shall be properly bonded to earth.

C16.12 PVC AND RUBBER INSULATED CABLES AND FLEXIBLE CORDS

General

The type of insulation, number of cores, size of conductors and sheathing are specified in the schedules or drawings.

P.V.C. and Rubber Insulated Cables

Unarmoured P.V.C. and rubber insulated cables shall be protected by conduit or trunking.

Conductors shall not be wrapped round stud terminals. Crimped lugs, applied with a tool specifically designed to prevent inadequate crimping, shall be used to connect cables to stud terminals. Care shall be taken to ensure that the cable insulation is not trimmed back beyond the lug.

Flexible Cords

Flexible cords shall be of the 300/300 volt grade or 300/500 volt grade to BS 6500, the type of insulation being suitable for the working temperature.

Where a flexible cord supports or partly supports a luminaire the mass supported by the cord shall not exceed the value given in Section 523-32 of BS 7671:2008.

C16.13 CONDUIT INSTALLATIONS

Steel Conduit and Fittings

Conduits shall be solid drawn or seamed by welding to BS 4568 : Part 1, and screwed heavy gauge steel, solid drawn or seam welded to BS 31 or BS 4568 : Part 1, for potentially explosive atmospheres.

The whole of the conduit system shall be mechanically and electrically continuous.

No conduit of less than 20mm diameter or greater than 38mm shall be used, unless by specific instructions.

If the type of steel conduit is not particularly specified in the Schedules or on the drawings, the type shall be determined as follows:-



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- (i) Steel conduits shall be either hot dip zinc coated inside and outside or sheradised to provide a minimum of Class 4 protection to BS 4568 : Part 1 if they are:-
 - a) embedded in concrete, cement or plaster
 - b) on the surface in kitchens, plantrooms, sub-stations, out buildings or any place which is likely to be damp
 - c) out of doors

Fittings used in conjunction with the above conduits shall be similarly protected.

- (ii) Steel conduits may be either stove enamelled or treated with air drying paint both inside and outside to provide a minimum of Class 2 protection to BS 4568 : Part 1 if they are surface mounted on walls or in ceiling or roof spaces which are dry.

Flexible conduit shall only be used on items of equipment which are withdrawable or subject to vibration or adjustment and shall be in accordance with BS 731 : Part 1. Electrical continuity shall be maintained by running outside the conduit a separate earth wire of minimum size 4 sq.mm with green/yellow P.V.C. sheath securely fastened at each end by its own tapped bolt, washer and lock washer.

Boxes shall be of the small circular type with steel covers to BS 4568 : Part 2 protected to match the conduit system.

Adaptable boxes shall be steel with overlapping lid to BS 4568 : Part 2 protected to match the conduit system.

Box covers shall be fixed by brass roundhead or cheesehead screws.

All bends shall be made on site to suit the condition and shall have a radius not less than that given in BS 4568 : Part 1.

Joints shall be screwed up tightly with as little thread showing as possible. Exposed threads shall be cleaned and painted immediately after erection to prevent rusting. Galvanised conduits shall be painted with cold galvanising paint.

Running couplings shall be kept to a minimum, but where they are used they shall be fitted with milled circular locknuts at each end of the coupling, firmly tightened when erecting the conduit. On vertical conduit run the running thread shall be above the coupling.

Electrical continuity shall be obtained by the use of spouted boxes or by means of a smooth bore male brass bush and earthing coupling with compression washer between the coupling and the box. Screwing conduit into unspouted boxes will not be accepted.

Plastic Conduit and Fittings

Plastic conduit may be used only when it is particularly specified. It shall be heavy gauge high impact complying with BS 4607 Part 1 and of 20mm minimum diameter.

Joints between conduits, conduit and conduit fittings and conduit and accessory boxes may be by push fit compression, mechanical locking or socket ends sealed and cemented with P.V.C. adhesive. In all cases requiring weatherproof or watertight protection the push fit compression arrangement only will not be acceptable.



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All bends shall be made on site using the correct size of bending spring. For large sizes and special conditions the recommendations of the manufacturer shall be followed.

Similar quality fixings and accessories of the same manufacture as the conduit shall be used throughout and be of the same colour. All accessories shall conform to BS 7671:2008 and shall be fitted with earthing terminals.

At all lighting points the conduit boxes shall be fitted with steel support inserts fixed to the structure to support ceiling mounted fittings.

On straight lengths of conduit expansion couplings shall be used as recommended by the conduit manufacturer. Expansion couplings shall also be used at building expansion joints.

Clamps and saddles shall be plastic and shall allow for lateral movement of the conduit.

Electrical continuity shall be maintained by running in the conduit a separate insulated earth wire with green P.V.C. sheath.

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

Installation

i) General

Conduits shall not be installed in contact with plumbing and mechanical services, a minimum distance of 150mm being maintained wherever possible.

Conduit shall be threaded to the required length by means of good quality dies. Conduit shall be well reamed, all burrs and surface oil shall be removed. All vice marks and other defacements of finish shall be well painted with good quality rust inhibitive paint immediately after erection.

Corners shall be turned by means of hand made bends or, where this is impracticable, by means of conduit boxes. Factory made bends, tees and elbows and inspection tees and elbows shall not be used without approval.

Not more than two right-angle bends will be permitted between draw-in boxes.

All conduits, boxes, and accessories comprising a circuit shall be erected before any wires in that circuit are drawn in. Ends of conduits left open during building operations shall be effectively plugged and the thread of metal conduit coated with petroleum jelly. Any blockages occurring in conduits shall be cleared. Conduits shall be swabbed through before commencing wiring.

Saddles and distance pieces shall have the same finish as the conduit for which they are to be used, be single way or multi-way as required and be fixed by means of screws in metal or other approved plugs. Wood or fibre plugs shall not be used. Saddles shall be fixed on either side of all bends, draw in boxes or sets.

In conduit runs containing cables of size up to and including 4 sq.mm a standard draw-in box or inspection fitting shall be included in every three lengths of conduit which shall not contain more than two right-angle bends.

Conduits shall be so arranged that it is impossible for water from condensation or other sources to lodge at any point. When this is not practicable drain holes 3mm diameter shall be drilled at the lowest points in the conduit runs or boxes at any other points necessary.



Steel conduits shall be supported at regular intervals not exceeding 1.2m and the distance from either side of any box or bend to the nearest saddle shall not be more than 150mm.

Conduit boxes to which lighting fittings are to be attached shall be fixed by substantial screws so that the weight of lighting fittings will not be carried by the conduit.

Any rusting of steel conduits occurring during building construction shall be removed with abrasive paper and the conduit repainted.

ii) Surface Conduit

Surface conduits shall be made to harmonise as far as practicable with the architectural features of the building. They shall be run only in vertical and horizontal directions except where it is desirable to follow the line of a constructional feature, in which case approval shall be obtained. Wherever possible, they shall be located in secondary rooms and stores and not in the main areas.

Surface conduits shall be securely fixed to the building fabric by means of distance saddles to BS 4568 : Part 2 to give not less than 6mm clearance between the conduit and the walls. In ceiling spaces where conduits are fixed to wood the distance pieces may be omitted.

In multiple runs crossing of conduits will not be permitted. Where a surface conduit turns through a wall a back outlet box shall be provided.

Where distribution boards are connected to trunking by conduits, the capacity of the conduits shall be sufficient to carry as many sub-circuit cables as there are ways in the distribution board. The supply cables shall be run in a separate conduit.

iii) Concealed Conduit

Conduits shall be installed in wall chases and ceiling voids in such a manner that inspection and draw boxes are at accessible positions. Draw boxes shall not be fixed in plastered walls unless specified.

Before any conduits are concealed earth continuity tests shall be carried out.

Conduit buried in plaster shall be fixed by crampets and installed so as to allow a minimum depth of plaster of 5mm over its entire length.

Where barium plaster is to be applied the conduit shall be covered by cement and boxes shall be built up to the edges with cement before plastering.

Conduits running from ceiling or roof positions to positions on walls shall be connected by a solid coupling 300mm below ceiling level.

Where distribution boards are erected a spare 25mm conduit shall be installed between the distribution board and the nearest duct or ceiling void terminating in a 50mm x 50mm adaptable box.

Extension rings shall be fitted to sunk conduit boxes to which lighting fittings or pull switches are to be attached if the distance between the conduit box and the finished ceiling or wall surface exceeds 10mm.

Boxes shall be erected so as to be recessed approximately 2mm below the finished wall or ceiling surface and in order that this requirement is met, the finished thickness of all walls and ceilings shall be verified on site.



Conduit buried in the ground shall be wrapped with P.V.C. self-adhesive tape half lapped. The taping shall extend for a distance of 150mm beyond the point where the conduit emerges from the ground.

iv) In Suspended Ceilings

Conduit runs in suspended ceilings shall be fixed to the building structure and not to the ceiling.

Where the ceilings are fixed and the ceiling void is inaccessible after completion, the outlet boxes on the ceiling shall be supported from the structure, and made accessible for re-wiring.

Where ceilings are of the demountable tile type the outlet box for the light fitting shall be fixed to the structure with a cable connection from the outlet box to the light fitting via 3 pin plug-in ceiling rose. The lighting fittings shall be individually supported using either 20mm conduit or 6mm dia. threaded rod. Where the light fitting is of the simple suspension type, i.e. tungsten fittings, the outlet box shall be brought to the ceiling surface in the same manner as that for a fixed ceiling.

All boxes for other apparatus, such as sockets and ceiling switches, shall be supported as specified for a fixed ceiling.

v) Under Wood Floors

Conduits under wood floors shall be run parallel with or at right angles to the joists. Where floor joists have to be cut or drilled to accommodate conduits running at right angles to them approval shall be obtained for the positions and sizes of the slots or holes.

Conduit boxes under floor boards shall be readily accessible for maintenance purposes. Floor traps or boards shall be securely fixed or re-fixed by brass countersunk greased wood screws with flush cup washers.

vi) Cast in Concrete

Conduit laid in concrete poured 'in situ' shall be fastened to the reinforcement before concreting. All conduit boxes shall be securely fixed to shuttering to prevent displacement.

Before any conduits are concreted, earth continuity tests shall be carried out.

Attendance during pouring shall be provided to ensure that conduits and accessories are not displaced.

vii) In Floor Screeds

Conduits shall be installed in floor screeds only when it is particularly specified.

Conduits shall be galvanised and care taken to ensure that runs do not foul the position of any door spring boxes.

Before any screed is laid the conduit shall be checked for rigidity and mechanical damage and earth continuity tests carried out.

viii) Supports for Plastic Conduits



Plastic conduits shall be supported at regular intervals not exceeding 900mm and the distance from either side of any box or bend to the nearest saddle shall not be more than 150mm.

C16.14 CABLES IN CONDUIT AND TRUNKING

General

Cables to be drawn into conduits or trunking shall be selected in relation to working temperature in accordance with the following table:-

Working temperature :	Cable :
not exceeding 65°C	450/750V grade PVC to BS 6004 HO7V-R/HO7V-U
not exceeding 80°C	85°C rubber compound insulated to BS 6007
not exceeding 145°C	150°C rubber compound insulated to BS 6007

The elastomer-insulated cables shall be identified throughout the length of the cable by the legends 'Heat Resisting 85' for 85°C rubber insulated and 'Heat Resisting 150' for 150°C rubber insulated either printed on a tape within the cable, or printed, indented, or embossed externally, the gap between the end of one legend and the beginning of the next not exceeding 300mm.

Multistrand conductors shall be used for 2.5mm sq. cables and above.

The number of cables drawn into any conduit or trunking shall not exceed those specified in Section 522-08 of BS 7671:2008.

Circuit cables shall not be drawn in until the conduit or trunking of that circuit is completed and the building weatherproof. Conduits shall not be dismantled for wiring operations.

During installation cables shall be combed to facilitate drawing-in and possible replacements.

Cable joints shall not be used unless specified on written approval.

Cables of A.C. circuits installed in steel conduit or trunking shall always be so bunched that the cables of all phases and the neutral conductor, if any, are contained in the same conduit or trunking.

Except in lighting installations including emergency circuits, cables from separate distribution boards shall be run in separate conduits.

Normal and emergency supply cables from different distribution boards feeding the same lighting points may occupy the same conduit providing they are separately identified and insulated to the higher voltage present.

Where cable of several circuits occupy the same trunking the cables of each circuit shall be bound together by clips or other approved means. Circuits shall be further grouped and bound to provide easy means of identification.



C16.15 TRUNKING INSTALLATIONS

Cable Trunking

All cable trunking shall be manufactured by a single Company who shall be accredited to the requirements of BS EN ISO 9002 for manufacture.

i) General

The trunking shall be supplied in standard lengths, each length including a coupling sleeve, and be free from all sharp edges and projections.

The lids of all trunking shall be drip proof and a tight fit securely fixed to the trunking by an approved means that will avoid damage to the cables. Self tapping screws or fixed bridge pieces shall not be used to hold the cover in position.

Flush type covers shall be fitted when trunking is installed flush with the building fabric. The finished edge of the trunking shall finish flush with the finished surface.

Vertical trunking shall be fixed to the building structure at intervals of 1.2m or as specified in the Schedules or drawings.

Horizontal trunking shall be either suspended by hanger fittings and conduit or mild steel rod or supported by mild steel or angle iron brackets. Suspensions and supports which will be visible shall be painted to match the trunking.

No suspensions or fixings shall intrude into the internal space unless otherwise specified.

Where trunking passes through walls and partitions the cover shall terminate at either side of the wall at a point 80mm from the wall. Between the removable covers a fixed section of cover shall be installed through the wall.

Manufacturers' standard fittings shall be used. Only where these are inadequate to meet special local situations will fabricated fittings be accepted. Where special fittings or sections of trunking are fabricated, they shall be prepared and finished to the same standard as manufactured standard items.

All trunking shall be provided with internal fire barriers in accordance with Section 527-02 of BS 7671:2008. Internal fire barriers shall be made by binding the cables and filling the spaces with suitable fire resistant material.

Trunking shall be run in vertical and horizontal directions except where it is desirable to follow the line of a constructional feature, in which case approval shall be obtained.

In vertical runs cable support pins shall be fitted at intervals not exceeding 5m for P.V.C. insulated cable or in accordance with Section 522-08 of BS 7671:2008 for other types of cables.

In horizontal runs cable retaining straps or holders shall be provided at intervals of not more than 1m where the lid is on the under-side of the trunking.

Connections between trunking and any equipment or apparatus shall be by means of flanged couplings, screwed conduit coupler with smooth bore bush or fixed insulated 'paxoline' type spacer pieces with fixed grommets. Direct attachment of trunking to equipment or apparatus without couplings or involving the need to cut the return edge of the trunking shall not be permitted.



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Where trunking connects directly to distribution boards, the cable entry point(s) shall be sized to accommodate cabling from all used and spare ways.

At constructional expansion joints the trunking shall be provided with a sliding coupling complete with flexible earth continuity tape.

Where conduits are connected to multi-compartment trunking, the trunking shall be drilled to allow the conduits to pass right through to the appropriate section, should direct access to a compartment not be possible.

ii) Steel Trunking (Not Bus Bar or Rising Mains Trunking)

Trunking and connectors shall comply with BS 4678 : Part 1, Class 3 finish unless otherwise specified.

A copper earth bonding link shall be fitted between adjacent lengths of trunking and between all trunking fittings and adjacent trunking, and supplied by the trunking manufacturer, arranged on the outside of the trunking and fittings on all surface trunking (see separate clause on Floor Trunking). These links are to be relied upon for earth continuity and must be of a size to comply with Section 543 of BS 7671:2008.

Steel thicknesses shall be at least 1.0mm for 50mm x 50mm trunking, 1.2/1.4mm for trunking above 50mm x 50mm and up to 150mm x 150mm and 1.6mm for trunking of 150mm x 150mm and above.

Where two or more services required to be segregated in accordance with Section 528 of BS 7671:2008 are installed in a common trunking they shall be effectively segregated by earthed steel partitions.

Trunking shall not be used on an outdoor installation unless the trunking and accessories have a hot dipped galvanised finish. In such an installation the trunking must not be installed in a position liable to give ingress to driving rain.

iii) Plastic Trunking

Plastic trunking may be used only when it is particularly specified.

The trunking shall be extruded unplasticised P.V.C. compound, of the type and colours indicated on the drawings or in the schedules.

The trunking shall be smooth inside and outside, free from imperfections and of high impact resisting heavy gauge type.

The trunking sections shall be jointed together using standard internal connectors without the use of solvents.

A stranded green/yellow insulated copper earth wire or bare copper tape conforming to Section 543 of BS 7671:2008 shall be run throughout the whole length of each trunking as the protective conductor.

Busbar Trunking

Busbar trunking shall be manufactured in mild steel not less than 1.6mm thick with 'tap-off' outlets as specified to take 'plug-in' units. Unused outlets shall be protected with removable steel cover plates.



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Busbars shall be of copper or aluminium as specified and shall be suitable for the current rating and fault levels specified. High grade insulating panels shall be spaced at frequent intervals to support the busbars and withstand the stresses set up under short circuit conditions. Provision shall be made for expansion of the busbars.

A substantial copper earth link shall be fitted external to the trunking to provide an efficient earth continuity path.

At outlet points provision shall be made to ensure that 'tap-off' units are effectively earthed before their contacts approach the live bars.

All trunking shall be provided with internal fire barriers in accordance with Section 527-02 of BS 7671:2008. Internal fire barriers shall be cement or glass fibre boards with gaps filled with glass wool or glass fibre material.

Trunking runs shall terminate in top end units which shall incorporate an insulated panel to ensure adequate support for the busbars.

Manufacturers standard fittings shall be used and shall incorporate the same features and finish as the main busbar trunking.

Incoming supply points shall be complete with removable cover plates and copper earth links to ensure satisfactory continuity of the system.

'Tap-off' units shall be designed to accept H.R.C. industrial cartridge fuse links. The units shall be enclosed in a sheet steel case with hinged door, and be so arranged as to prevent the accidental reversal of phases and be finished to match the trunking.

Rising Mains Trunking

Rising main trunking shall be manufactured from sheet steel and be stove enamelled. Each length of trunking shall be complete with all mechanical and electrical connections and fixing brackets.

The busbar riser covers shall be fixed with screws at each side of the busbar section. At each distribution board take-off position an insulating panel shall be fitted within the busbar section between the busbar and the cover.

Busbars shall be of copper or aluminium as specified and shall be suitable for the current rating and fault level specified. High grade insulating panels shall be spaced at frequent intervals to support the busbars and withstand the stresses set up under short circuit conditions. The neutral conductor shall be of the same cross-sectional area as the phase conductors and under no circumstances must the conductors be reduced at take-off points.

At the bottom of the riser, a set of thrust blocks shall be incorporated to secure and support the busbar conductors. Provision shall be made for expansion of the busbars.

A heavy gauge sheet steel cable entry unit shall be fitted to the type of cable specified.

All trunking shall be provided with internal fire barriers in accordance with Section 527-02 of BS 7671:2008. Internal fire barriers shall be cement or glass fibre boards with gaps filled with glass wool or glass fibre material.

Coloured P.V.C. sleeving shall be fitted to the conductors where they pass through supports or fire barriers.



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At each floor level the inter-connections between the busbars of the riser and the switchgear shall be P.V.C. covered flexible copper braid securely connected to the busbars by means of two part clamps or solid copper bars securely clamped to the riser busbars. These inter-connections shall be phase coloured.

A 25mm x 4mm tinned copper earth continuity conductor shall be run the full length of the rising main. The conductor shall be fixed externally to the side of the trunking by a suitable bolt and double nuts at a maximum spacing of 900mm and each section of the rising main shall be securely bonded to the tape. The earth continuity tape shall be fitted after the rising main is erected and the minimum unbroken length of the earth continuity tape shall be 15m or as specified on the drawings.

All distribution boards shall be securely bonded to this earth continuity conductor.

Joints shall be riveted with copper rivets and soldered overall after riveting.

The rising mains shall be so designed, that complete erection can be effected after the building is watertight.

The system should be arranged so that busbars may be capable of extension without undue disturbance of other equipment.

Floor Trunking

Trunking and connectors shall comply with BS 4678 : Part 2.

The type of floor trunking shall be as specified and the positions of runs, junction boxes and outlets shall be as shown on the drawings.

When two or more services are required to be segregated in accordance with Section 528 of BS 7671:2008 each service shall be run in either a separate compartment in a common trunking or in separate trunking. The segregation shall also be carried through junction boxes.

Trunking floor outlets shall be either mounted on turret boxes or in recessed boxes set below the floor finish as specified.

Trunking shall be accurately lined up before screeding commences. Voids underneath the trunking shall be avoided by laying 'causeways' of cement on the slab following the route of the trunking, the latter being tamped down, levelled off and fixed.

Screwed holes used for fixing lids and components shall be well greased and the screws inserted before screeding commences and the screws not removed until the screed is hard.

Copper earth bonding links shall be fitted between adjacent lengths of trunking and between all trunking fittings and adjacent trunking, and supplied by the trunking manufacturers, arranged on the outside of the trunking and fittings. These links are to be relied upon for earth continuity and must be of a size to comply with Section 543 of BS 7671:2008.

Skirting Trunking

Skirting trunking runs and positions of outlets shall be as shown on the drawings. Where two or more services are required to be segregated in accordance with Section 528 of BS 7671:2008 each service shall be run in a separate compartment in a common trunking.



Removable telephone plates shall not expose live terminals or if common plates are used the terminals of main socket outlets shall be shrouded.

Lighting Trunking

The type of lighting trunking shall be as specified and the position of runs and luminaires shall be as shown on the drawings.

C16.16 CABLE TRAY AND CABLE BASKET

Metal Cable Tray

All cable tray shall be manufactured by a single Company who shall be accredited to the requirements of BS EN ISO 9002 for manufacture.

Cable tray thickness shall not be less than 0.9mm up to 150mm width and 1.5mm for widths between 150mm and 300mm.

Trays shall be galvanised or have a rust resistant finish except where it is installed in corrosive atmospheres when the tray and any associated components shall be PVC or 'Kelvar' coated.

Cable tray installed in plantrooms, service risers, floor voids, ceiling voids or other non-exposed areas, shall be galvanised finish to BS EN 10143, G350 coating weight, Z2 bending grade.

Cable tray installed in exposed areas shall be galvanised finish to BS EN ISO 1461 or BS EN ISO 12944 : Section 2, dependent upon application.

The tray shall be of adequate size to support the cables without undue bunching and so supported that it will carry the cable load without undue deflection of the tray. It shall be perforated to facilitate the fixings of cables to the tray.

Fixings to wall or steelwork shall be by sheradised nuts and bolts with a gap of 25mm between structure and tray. All supporting steelwork shall be galvanised. Fixings shall be at regular intervals not exceeding 1.2m and at 225mm from bends and intersections.

All joints in sections of cable tray and fixings of tray to support brackets shall be achieved by means of round or mushroom headed bolts and nuts. The bolts and nuts shall be installed with the bolts on the inside of the tray, clear of any cables.

Manufacturers' bends and intersections shall be used and when sections are cut, all sharp edges shall be removed and exposed metalwork painted with rust inhibiting paint. Holes through tray shall be similarly treated and suitably bushed.

Cables shall be fixed by proprietary saddles or clips as specified.

Where uncoated tray carries cable having a P.V.C. or other insulating oversheath, or where insulating clips are used to fix metal sheathed and/or armoured cables to uncoated tray, a definite earthing connection to the tray shall be made.

P.V.C. Cable Tray

P.V.C. tray plate shall only be used where specified or approved.



Wire Basket

All wire basket type cable tray shall be zinc plated wire rod except where it is installed in corrosive atmospheres when the basket and any associated components shall be stainless steel. The wire rod shall be of minimum diameter 3.5mm (up to 50mm side depth) or 5.0mm (above 50mm side depth).

Manufacturer's bends, crossovers, reducers, couplers, and the like shall be used throughout. Site fabricated sections shall not be permitted. When sections are cut, all sharp edges shall be removed and exposed metalwork painted in accordance with the requirements of the Painting clause elsewhere in this Specification.

The wire basket shall be bonded throughout its length at each joint and intersection with a 10mm² bonding conductor and at any Telecomms Equipment racks with a 25mm² bonding conductor. In addition, the wire basket shall be bonded to the suspended ceiling grid or raised floor grid using 10mm² bonding conductor, one bond being installed per 30sq.metres of floor or ceiling.

All wire basket shall be manufactured by a single Company who shall be accredited to the requirements of BS EN ISO 9002 for manufacture.

The wire basket shall be of adequate size to support the cables without undue bunching and so supported that it will carry the cable load without undue deflection of the tray.

When installed under raised floors, the wire basket shall be fixed to the structure utilising manufacturer's proprietary stand-off brackets giving a minimum clearance of 10mm between the basket and the structure.

Fixings to walls or steelwork shall be by utilising manufacturer's proprietary brackets with a gap of 25mm between the basket and the structure.

All supporting steelwork and fixings shall be hot dipped galvanised finish or the same finish as the basket. Fixings shall be at regular intervals not exceeding 1.2m and at 225mm from bends and intersections.

All joints in sections of wire basket and fixings to support brackets shall be achieved by means of round or mushroom headed bolts and nuts. All bolts and nuts shall be sheradized after manufacture and be installed with the bolts on the inside of the basket, clear of any cables.

Data and Voice cables shall be fixed by proprietary cable PVC ties. Low Voltage armoured or unarmoured cables shall be fixed in accordance with the requirements detailed elsewhere in this Specification.

Manufacturer's standard conduit termination plates shall be installed at all locations where solid or flexible conduit terminates on or at the cable basket.

Installation

Where cable tray or cable basket runs are located vertically above other cable tray or cable basket, the vertical space between the underside of the upper tray or basket and the top of the return edge of the lower tray or basket shall be equal to the width of the largest tray or basket used or 300mm, whichever is the larger dimension.



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Where cable tray or cable basket runs cross other cable tray or cable basket at an angle of 45° or greater, the vertical space between the underside of the upper tray or basket and the top of the return edge of the lower tray or basket shall be equal to the width of the largest tray or basket used or 75mm, whichever is the larger dimension.



PART C - SECTION 17

ABOVE GROUND SOIL, WASTE, VENTILATION & RAINWATER INSTALLATION

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PART C - SECTION 17

ABOVE GROUND SOIL, WASTE, VENTILATION & RAINWATER INSTALLATION

C17.1 GENERAL

The above ground disposal system shall be installed to comply with all statutory and local authority regulations, with particular reference to the following:-

- a) BS EN 12056-2000 for sanitary pipework and rainwater pipework.
- b) The Building Regulation documents.
- c) The Plumbing Engineering Services Design Guide compiled and published by the Institute of Plumbing.
- d) The requirements of the Environmental Health and Building Control Officers.
- e) Manufacturers design stipulations and recommendations for installation and testing.

All reference documents should be the current editions.

These services shall be installed in accordance with the regulations of the Local Authority and Water Board, and the like. Where these are found to be at variance with any clause in this specification immediate notice must be given to the Services Engineer.

All the work shall be carried out under the direct supervision of a Registered Plumber.

Local trade customs shall be followed in so far as the employment of plumbers on copper pipework and all pipework in the drainage system i.e., rainwater, soil, waste and vent pipes and the like.

Main routes for soil, waste and vent stacks shall be strategically placed in order to accommodate the provision of toilet facilities, catering areas, leisure amenities, laboratory processes, and the like including all branch waste pipework. The routing of such pipework shall be within general vertical service ducts and horizontal service voids, although it is accepted that by the nature of the service requirements, separate singular routes shall be required adjacent to structural columns or surface mounted, and the like in order to maintain gravitational conditions. The positioning of external rainwater pipework shall be agreed with the Architect and any variance in this is to be brought to the immediate attention of the Services Engineer.

Ventilation of the soil and waste system/systems shall be to atmosphere via vent terminals through the roof. All sub-vent requirements from all sanitary appliances are to return to the main vent system. Where there are isolated groups of sanitary fittings a separate vent is to be routed to discharge through the roof. The provision of air relief valves are not to be included, with the possible exception of single sanitary waste appliances located within isolated areas.

The installation of the above ground drainage system, including connections to the below ground foul and surface water drains and the testing of such connections, shall form a part of this section of the works.

C17.2 PIPEWORK MATERIALS

The materials for the installation shall be, one of the following as detailed on the drawings:



- a) Soil, waste and vent stacks (SWVP's) – cast iron – UPVC, prefabricated galvanised mild steel or prefabricated seamless copper.
- b) Vent pipes (VP's) and anti-syphon pipes (AS's) – UPVC.
- c) Waste pipes (WP's) – UPVC - copper - Vulcathene.
- d) Internal rainwater pipes (RWP's) – *Cast Iron, - UPVC, Prefabricated Galvanised Steel.
- e) Lightweight stainless steel with push fit jointing system, manufactured to BS EN 1124 Parts 1 and 2, with BBA approval 86/1751.

Cast Iron Pipes

Cast iron for the main stack routes shall comply with the BS EN 877. Pipes shall be coated internally with epoxy externally with acrylic anti-rust red primer. Fittings shall be coated internally and externally with epoxy anti-rust red resin.

or

Cast iron pipes in compliance with BS 416. Pipes shall be coated internally with epoxy pitch paint and externally with black alkyd paint.

Prefabricated Galvanised Mild Steel Pipes (GMS)

Galvanised mild steel for the main stack routes and larger branches shall be manufactured from mild steel to BS 1387, with completed units, after washing and cleaning, dipped in molten zinc coating all surfaces, internally and externally to BS 729 and finished components inspected to BS 5750.

Copper Pipework

Copper pipework for the minor waste branch routes up to and including 54mm diameter, in accordance with BS EN 1057 R250. All pipework fittings shall be compression type or capillary type (with rodding access) and lead free solder, and shall be installed strictly in accordance with the manufacturer's instructions.

U.P.V.C. Pipework

Unplasticised PVC for main stack routes, waste branches and anti-syphon vent pipe installations and 'compact' toilet facilities (i.e. Integrated Plumbing Systems) shall be in accordance with BS 4514 and BS 5255, as applicable. All pipework fittings shall be socket and spigot solvent welded joints with the facility of forming expansion joints via seal ring adapters and care must be taken to allow for expansion as recommended by the manufacturer.

Vulcathene Pipework

Vulcathene (Mechanical) pipework for all laboratory process requirements in accordance with BBA 91/2805. All fittings shall be compression type assembled with the correct manufacturer's tools, and with the facility of forming anchored expansion joints whose location is to be strictly in accordance with the manufacturer's recommendations.



Stainless Steel Pipework

Lightweight stainless steel, AISI 304 grade, pipework for all above ground drainage stacks, both sanitary and rainwater, up to and including 200mm diameter, manufactured in accordance with BS EN 1124 parts 1 and 2. All pipework fittings shall be push fit with EPDM sealing rings to BS 2494: 1986, and shall be installed strictly in accordance with the manufacturer's instructions. All pipework shall be jointed using the pipework manufacturer's standard system, however, "dimpling" and associated joint clamps shall be provided at the base of all vertical stacks and change of direction of rainwater pipework to ensure push fit jointing system remains secure after installation.

C17.3 GENERAL DESCRIPTION OF THE CAST IRON PIPEWORK (MECHANICALLY JOINTED SYSTEM)

Cast iron pipework up to and including 225mm dia shall be mechanically jointed as manufactured by:-

"Timesaver" or "Ensign" System by : Saint-Gobain Pipelines
Sinclair Works
PO Box 3, Ketley
Telford, Salop, TF1 4AD
Or equal and approved

The mechanically jointed system comprises of cast iron pipes, centrifugally cast in lengths of up to three (3m) metres. All pipes under this system are double spigotted. Bends, branches, access pipes and other fittings under this system are also spigotted so as to complement the system.

The joint consists of a synthetic rubber gasket, which makes the seal between the two spigot ends, and, two cast iron clamps or one stainless steel clamp, assembled over the gasket.

The clamps are bolted using stainless steel bolts and nuts, with the nuts tightened using a pre-set torque wrench or powered tool as recommended by the pipework manufacturer.

All mechanical couplings shall be of the type which satisfy the current edition of the Institute of Electrical Engineer Wiring Regulations for equipotential bonding. Where couplings not meeting these standards are used the Contractor shall offer an alternative form of earth bonding to the satisfaction of the Engineer.

All pipework and fittings shall be installed and jointed as per the manufacturer's instructions.

All pipework shall be carefully aligned before jointing.

All pipes that have to be cut shall be cut with pipe cutters or a method approved by the Services Engineer and be cut and coated with a bitumastic paint, Mastecol No. 8 as supplied by Messrs W H Keys, Church Lane, West Bromwich, B71 1BN, to prevent corrosion, or other equal and approved.

All horizontal junctions shall have additional 45° angled brackets either side of each junction, in order to prevent deflection.



Cast Iron Pipework Supports

All vertical pipes shall be supported on standard brackets as supplied by the manufacturers and shall be secured back to walls using 12mm galvanised drop rod and rawl bolts, or other equal and approved method of fixing.

When fixing to steel columns the column shall be drilled and tapped to suit the rod or bolt diameter, prior to any fire protection of steelwork.

In certain instances, it may be necessary to provide packing pieces between the brackets and the wall surface to suit the stack centre lines.

All horizontal pipes shall be supported from the underside of concrete floors using No. 12 rawl bolts, 12mm galvanised drop rod and the Flamco support system (or other equal and approved), Flamco rail and 12mm galvanised drop rod and standard cast iron pipe brackets.

Pipework supported from the underside of the general roof area shall be supported from roof structural steel and the Flamco support system, as described above. The Flamco system being adapted to suit roof steel configuration where necessary.

All cast iron pipework shall have a minimum of 2 No. clips between floor and soffit and at not more than the following intervals, or as detailed on the drawings :

Diameter of Pipe	Interval for Vertical Runs	Interval for Horizontal Runs
50mm	2.5m	1.5m
75mm	2.0m	2.0m
100mm	2.0m	2.0m
150mm	2.0m	2.0m

Painting Cast Iron Pipework and Fittings

On completion of the installation, the cast iron pipework and fittings shall be cleaned and painted with one coat of bitumastic paint, Mastecol No.8, or other equal and approved.

Cast Iron Floor Drains (Above Ground Floor Level)

To be manufactured by Wade International (UK) Limited, Stanstead, Essex or F C Frost Limited, Braintree, Essex, and to be fitted strictly to the manufacturer's instructions. Shape and finish of outlet as determined by floor finish and architectural considerations.

C17.4 GENERAL DESCRIPTION OF GALVANISED MILD STEEL PIPEWORK (PREFABRICATED G.M.S.)

Galvanised mild steel pipework components shall be the ECONA system push-fit jointed and as manufactured by:-



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KONAFLEX Ltd
Unit 2
Northcote Road
Stechford
Birmingham, B22 9BE

The system comprises of factory made prefabricated units incorporating spigot and sockets with push-fit joints between units.

The socket joint contains a 'CEALFIT' synthetic rubber gasket to BS 2494, which makes the seal with the spigot of the adjacent unit.

Each joint shall incorporate provision to satisfy the current edition of the Institute of Electrical Engineers Wiring Regulations for equipotential bonding.

All pipework and fittings shall be installed and jointed as per the manufacturer's instructions.

All pipework shall be carefully aligned before jointing.

All pipes that have to be cut shall be cut with pipe cutters or a method approved by the Services Engineer and be cut and coated with an anti-corrosive treatment recommended by the component manufacturer.

G.M.S. Pipework Supports

All vertical pipes shall be supported on standard brackets as supplied by the manufacturers and shall be secured back to walls using 12mm galvanised drop rod and rawl bolts, or other equal and approved method of fixing.

When fixing to steel columns the column shall be drilled and tapped to suit the rod or bolt diameter, prior to any fire protection of steelwork.

In certain instances, it may be necessary to provide packing pieces between the brackets and the wall surface to suit the stack centre lines.

All horizontal pipes shall be supported from the underside of concrete floor using No. 12 rawl bolts, 12mm galvanised drop rod and the Flamco support system (or other equal and approved), Flamco rail and 12mm galvanised drop rod and standard pipe brackets.

Pipework supported from the underside of the general roof area shall be supported from roof structural steel and the Flamco support system, as described above. The Flamco system being adapted to suit roof steel configuration where necessary.

Each galvanised pipework component shall have a minimum of 2 No. clips between floor and soffit and at not more than the following intervals, or as detailed on the drawings:



Diameter of Pipe (mm)	Interval for Vertical Runs (mm)	Interval for Horizontal Runs (mm)
50mm	2.5m	1.5m
75mm	2.0m	2.0m
100mm	2.0m	2.0m
150mm	2.0m	2.0m

C17.5 GENERAL DESCRIPTION OF THE PLASTIC PIPEWORK

Plastic pipework above 35mm dia. up to and including 160mm dia shall be jointed by the push fit system/solvent welded as manufactured by:-

Polypipe Terrain Ltd
Aylesford
Maidstone
Kent
ME20 7PJ

Wavin Building Products Ltd
Parsonage Way
Chippenham
Wiltshire
SN15 5PN

Marley Extrusions Ltd
Lenham
Maidstone
Kent
ME17 2DE

or similar approved.

Plastic pipework up to and including 50mm diameter shall be high temperature rating as Gerberit Terrain 200 HIGH TEMPERATURE PVC waste system, or other equal and approved.

The installation of the systems shall be fully in accordance with the specific manufacturers instructions and in particular to the provision of bracket/fixings and expansion joints to allow for thermal movement.

All PVC pipework shall be checked before fitting to ensure that it is free from any cuts on its surface or any other malformation.

All exposed plastic pipework shall be coloured white.

Typical Examples of Expansion Joint Locations

- At the foot of soil and/or rainwater stacks and immediately above each floor level with each expansion fitting anchored.
- On all horizontal pipework or lengths greater than 2.0M between fixed points and a maximum distance of 3.0M centres between expansion points and with each expansion joint suitably anchored.



Note : Anchor points for all horizontal pipework will require purpose made anchor brackets using additional 6mm galvanised drop rod angled at 45°C against the anticipated direction of thermal movement.

It is recommended that the advice of the PVC manufacturer be obtained, in particular situations and/or the approval of the Services Engineer.

Where PVC pipes are in close proximity of heat (radiators, steam and hot water pipes, and the like) they shall be adequately protected with insulation using 25mm fibreglass performed rigid sections canvas backed approximately 300mm either side of the heating/hot water pipework.

PVC Pipework Supports

All PVC pipes shall have a minimum of 2 No. clips between floor and soffit and at not more than the following intervals.

Diameter of Pipe (mm)	Interval for Vertical Runs (mm)	Interval for Horizontal Runs (mm)
Up to 50	900	750
82 to 110	1300	750
160	3000	950

All vertical pipes dropping on steel columns shall be supported on galvanised mild steel holderbats (similar to Gerberit Terrain, Reference 142), cut to length and with a 75mm x 25mm x 6mm mild steel back plate drilled twice for 6mm bolts and welded to the holderbats for fixing to the steel column. The purpose made bracket shall be re-galvanised on completion before fixing.

Where pipes drop on walls or partitions, they shall be supported on standard brackets as supplied by the manufacturers and secured back to the walls/partitions using the correct size of zinc plated woodscrews with plastic type plugs, as recommended by the manufacturer.

In certain instances it may be necessary to provide packing pieces between the brackets and the wall surface to suit the stack centre lines.

All horizontal pipes shall be supported from the insitu fixings, as described for Cast Iron Pipework and Fittings, together with the Flamco Support System, including pipe clips with nylon inserts, Flamco rail and 6mm galvanised drop rod.

Note : PVC soil waste pipework at low level above floor level to service ducts shall be supported on purpose made galvanised mild steel brackets to suit height and fall of the soil waste pipework.

PVC Special Fittings

This section of the works shall be responsible for ensuring that the PVC installation can be installed using standard fittings or "Special Fittings" obtainable from the manufacturers.



PVC Method of Construction

All pipes shall be carefully aligned and shall be jointed and installed as recommended by the manufacturer using the following method :-

All pipes must be cut square and all swarf removed.

Offer up the pipe to the fitting and mark for alignment.

Clean spigot ends and inside sockets with cleaning fluid supplied by the manufacturer.

Thoroughly coat-contacting surfaces of pipe and fittings with solvent weld cement supplied by the manufacturers, using a clean brush of suitable size and assemble joint immediately. Twist fitting to ensure complete contact and alignment.

Remove excess cement squeezed out of joint.

Joint may be handled in 3 or 4 minutes (allow longer in cold conditions).

The joint achieves full strength in 12 hours.

Seal Ring Adapters

To convert any socket into an expansion joint, clean seal ring adapter and bead around socket of fitting with cleaning fluid.

Apply solvent weld cement to contacting surfaces of adapter and fitting, assemble immediately by placing seal ring adapter over socket and pressing home, ensuring it is squarely in position.

Remove excess cement squeezed out of joint from inside and outside the fitting.

Assembled fitting may be handled in 3 to 4 minutes. Position rubber seal ring in groove, taking care not to foul the ring with solvent.

Waste boss connections when fitted to pipes shall consist of two parts with inner and outer flanges, solvent welded as a complete unit with inbuilt gradients for the waste pipes of 1¼°.

Where it is not possible to gain access to the bore of the soil pipe, purpose made bosses with integral clamping action may be used, provided that the mating surfaces are suitable for any used with solvent cement.

Waste connections to branch fittings as necessary shall be solvent welded to set positions of its branch fitting.

Fire Sleeves for PVC Pipework

Where PVC pipework of 40mm diameter and above passes through walls or floors which are not located within the same fire compartment, they shall be fitted with fire sleeves, similar to Dufalite, Quelfire, Terrain, or other equal and approved.

All fire sleeves shall be installed strictly in accordance with the manufacturer's instructions.



C17.6 GENERAL DESCRIPTION OF COPPER PIPEWORK AND FITTINGS

All copper pipework shall be copper tube in accordance with BS EN 1057 R250. Each length of tube shall bear the British Standard/European Kitemark.

General

Pipework after cutting shall be free from burrs and other defects and shall be cleaned before erection. The Services Engineer will require a demonstration to show that burrs have been removed by dismantling six sections of the pipework. The cost of removing and replacing the section shall be included as part of the section of the work.

If the Services Engineer is not satisfied with the workmanship, all joints throughout the works shall be removed, corrected and replaced at no extra cost.

Jointing

All copper waste pipes, up to and including 54mm C.U. shall be jointed by compression type fittings, similar to those manufactured by Yorkshire Imperial (Metals) Limited, or other equal and approved.

Copper Pipework Supports

Exposed pipework at Low Level Above Floor level :

All exposed copper pipes shall be supported with brass schoolboard clips secured to walls with plastic plugs and 25mm (1") 10 brass screws, or wall/floor plate drop rods and brass munsen ring type.

Horizontal pipework shall be supported as described for PVC pipework using Flamco Rail, clips, nylon inserts and galvanised drop rod.

Copper pipes shall be supported at not more than the following intervals.

Diameter of Pipe (mm)	Interval for Vertical Runs (Metre)	Interval for Horizontal Runs (Metre)
35	3.0	2.4
42	3.0	2.4
54	3.0	2.7

Wherever practicable, large radius bends (machine or spring bends) shall be used. Manufactured bends and elbows will only be permitted as detailed on the drawings, or with the approval of the Services Engineer.

Copper pipework at low level above floor level within service ducts shall be supported on purpose made galvanised mild steel brackets to suit the height and fall of the waste pipework.



C17.7 GENERAL DESCRIPTION OF THE LIGHTWEIGHT STAINLESS STEEL PIPEWORK (PUSH FIT JOINTED SYSTEM)

Lightweight stainless steel pipework up to and including 200mm diameter shall have push fit joints as manufactured by :-

“Europipe” System by : BLUCHER UK Limited
 Station Road Industrial Estate
 Tadcaster
 North Yorkshire
 LS24 9SG

The push fit jointed system comprises of lightweight AISI 304 grade stainless steel pipes, manufactured in accordance with BS EN 1124 Parts 1 and 2, in lengths of up to six (6m) metres, (200mm diameter pipework is available only up to three (3m) metre lengths. All pipes under this system have spigot and socket ends. Bends, branches, access pipes and other fittings under this system are also spigot and socket, so as to complement the system.

The joint consists of a synthetic EPDM rubber gasket, which makes the seal between the spigot end and the socket into which it is offered.

All jointing shall satisfy the current edition of the Institute of Electrical Engineer Wiring Regulations for equipotential bonding. Where joints do not meet these standards the Contractor shall offer an alternative form of earth bonding to the satisfaction of the Engineer.

All pipework and fittings shall be installed and jointed as per the manufacturer's instructions.

All pipework shall be carefully aligned before jointing.

All pipes that have to be cut shall be cut and bevelled using the manufacturer's specialist tools using the methodology recommended by the pipework manufacturer. Where additional joint security has been specified the contractor shall employ the pipework manufacturers specialist “dimpling” tool and joint clamps.

All horizontal junctions shall have additional 45° angled brackets either side of each junction in order to prevent deflection.

Stainless Steel Pipework Supports

All vertical pipes shall be supported on standard brackets as supplied by the manufacturers and shall be secured back to walls using 10mm galvanised drop rod and rawl bolts, or other equal and approved method of fixing.

When fixing to steel columns the column shall be drilled and tapped to suit the rod or bolt diameter, prior to any fire protection of steelwork.

In certain instances, it may be necessary to provide packing pieces between the brackets and the wall surface to suit the stack centre lines.

All horizontal pipes shall be supported from the underside of concrete floors using rawl bolts, 10mm galvanised drop rod and the Flamco support system (or other equal and approved).



Flamco rail and 10mm galvanised drop rod and pipework manufacturers standard pipe brackets.

Pipework supported from the underside of the general roof area shall be supported from roof structural steel and the Flamco support system, as described above. The Flamco system shall be adapted to suit roof steel configuration where necessary.

All Stainless steel pipework shall have a minimum of 2 No. clips between floor and soffit and at not more than the following intervals, or as detailed on the drawings :

Diameter of Pipe	Maximum Interval for Vertical Runs	Maximum Interval for Horizontal Runs
All sizes	3m	3m

C17.8 PIPEWORK INSTALLATION STANDARDS

All pipes and fittings shall be stored clear of the ground on a level surface with securely staked end pipes to prevent collapse of stack, adequately protected from the elements. Storage shall comply with the manufacturers recommendations, pre-packed pipe bundles shall not be opened until required.

Each pipe shall be carefully examined before installation. Cast iron pipes and fittings shall be struck with a light hammer or mallet to test for soundness. Check bore and all external surfaces for malformation or defects. Reject all damaged pipe and fittings.

No pipes shall be jointed together before installation.

All vertical pipework shall be set true to line and carefully aligned before jointing.

Horizontal pipework shall be set true and even to gradient. Minimum gradients shall be : -

150 mm dia – 1 in 80
100 mm dia – 1 in 60
75 mm dia and below - 1 in 50

All antisiphon vent pipework shall have, where possible, an even backfall of 1 in 100 to the vertical connection from the vent from any sanitary appliance, offsets shall be permitted providing they do not form a trap that may collect condensation.

All fittings for use in the sanitary pipework installation shall be of the swept type with largest radius possible.

All 90° bends on main stack routes shall be formed by the use of 135° fittings or long radius machined bends.

Pipe bending shall only be permitted where approved, bending apparatus and suitable size formers are employed.



Joints General

Where pipes pass through floors or walls wherever possible no joints shall be permitted within the floor or wall thickness.

Where joints are made within the wall or floor thickness, the joint shall be wrapped for a minimum of 100mm either side of the joint with an approved protective anti-corrosion tape.

Joints between dissimilar materials shall only be carried out using the manufacturers recommended joints/methods. Joints where electrolytic corrosion may occur shall not be installed under any circumstances.

Sleeving

Where pipes pass through floors and walls, pipe sleeves shall be provided. These shall extend to the full finish thickness of the wall or floor and be secured against movement and shall be fire stopped with Rockwool or similar and approved.

All non metallic pipe 40mm dia or over penetrating through fire compartment walls/floors shall be protected by a fire stop sleeve which has been tested to BS 476 : Part B and will maintain its integrity for the minimum fire rating of the compartments components. All fire sleeves shall be installed strictly in accordance with the manufactures instruction.

Where UPVC pipes pass through floors the pipe sleeve shall be packed with Rockwool, leaving a depth of 15 mm below top of the sleeve and the remainder filled with silicone mastic.

Wall, floor and ceiling plates shall be fitted where pipes pass through finished surfacing in open areas.

Access

Access shall be provided above each floor level and at the base of each soil waste and vent stack and where indicated on the drawings. Access shall be by means of a removable plate/cap giving full bore access.

Access shall be provided at the base of each rainwater pipe and where indicated on the drawings.

Branch waste pipes shall be provided with access at each change of direction and adjacent to sanitary fittings.

In addition to the above access shall be provided where indicated on the drawings.

Where access is provided the Sub-Contractor shall ensure that it is so positioned as to be accessible, particularly in connection with the positions of adjacent services.

Where possible access points shall be located above the flood level of adjacent fittings.

The upstream end of all soil laterals shall be upturned terminating with an access located above the flood level of adjacent fittings.



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All internal access points shall form a gas tight seal when closed and be secured by a mechanical means to prevent dislodging by internal system pressure.

Before testing all access points shall be removed and inspected and re-assembled by the Contractor.

Traps and Connections to Sanitary Appliances

The Sub-Contractor shall supply and install a two (2) piece tubular or bottle type trap of the appropriate size adjacent to the sanitary fitting.

Traps shall comply with the following standards :

Cast Iron	BS 437
Copper	BS 1184
Plastic	BS 3943

All traps other than the w.c. shall have a 75mm deep water seal unless indicated otherwise.

Where indicated waste traps shall be 'ANTIVAC' type as manufactured by McAlpine & Co Ltd, or equal and approved.

The W.C. shall have a 50mm deep water seal.

All traps up to and including 75mm diameter shall have a coupling nut on the inlet and a compression type joint on the outlet to facilitate easy removal of the trap for access.

The joint between the waste outlet and appliance shall be bedded in a waterproof jointing compound and fixed with a resilient washer between the appliance and waste outlet backnut.

The joint between W.C. pans and soil pipe shall be via BS 5627 flexible connector with a minimum 5° angle installed in accordance with the manufacturers recommendations.

The Sub-Contractor shall make the final connections between the sanitary appliances and soil pipe/trap.

Where indicated on the drawings, sanitary schedule or directed by the Engineer/Architect, the Sub-Contractor shall install chromium plated traps.

Commencement Point

The sanitary pipework installation shall commence as shown on the drawings and shall connect to drain spigots/sockets provided by the sub contractor at the lowest floor slab level.

Where cast iron, galvanised mild steel, copper, UPVC or Vulcathene connects to the below ground drainage the correct polypropylene adapter shall be used.

Where the below ground drainage connection is not in the correct position, this shall be brought to the immediate attention of the Services Engineer.



Termination

Where pipe stacks pass through a roof a connector of an approved type, compatible with the roof structure/finish giving a watertight joint shall be installed.

Pipe stacks shall be carried to full bore 450mm above roof level and in any case not less than 900mm above the head of any window within a horizontal distance of 3000mm from the stack.

All stacks shall be provided with a domical cage permanently secured to the pipe.

Prevention of Pipeline Obstruction

The Sub-Contractor shall complete all joints as specified and then check the bore of the pipe is clear of any obstruction before installation of the next pipe. Care shall be taken that there is no irregularity at the joint.

Temporary sealing and protection of all open ends of pipework shall be completed in order to prevent damage to the pipes and avoid debris, and the like from entering the soil waste and vent stacks and rainwater stacks.

Pipework shall be kept free from mud, debris, cement, plaster, and other obstruction during installation and until completion of the contract.

The Sub-Contractor shall ensure that during construction all open ends of pipes are temporarily sealed to prevent the ingress of debris.

The Sub-Contractor shall carry out regular checks to ensure that all temporary sealing plugs and access points are intact.

C17.9 OVERFLOWS

The Sub-Contractor shall supply and install a 20 mm UPVC overflow if required from each of the WC cisterns to discharge as indicated on the drawings or in the specification.

C17.10 PREFABRICATED PIPEWORK

All prefabricated pipework shall be constructed from materials of the standard indicated in this specification or to standards agreed with the Engineer. All prefabricated pipework shall be constructed in workshops equipped for the purpose. All fabrication work (i.e., welding, brazing etc.) shall be carried out by competent operatives holding the appropriate recognised certificates.

All pipework, fittings and brackets shall be constructed of compatible materials to ensure the installation is free from electrolytic corrosion.



Before commencement of pipework fabrication the Sub-Contractor shall submit the proposed fabricated drawings for the comment of the Engineer. The Sub-Contractor shall ensure that the scheme and setting out drawings are the current editions and that he possesses all the information required before commencement of work. The pipework shall be prefabricated to suit site dimensions and in such a manner so that it can be installed in the positions indicated on the drawings and in accordance with the contract programme.

The Sub-Contractor shall allow the Engineer or his approved representative free access to inspect the pipework at any time during fabrication.

All prefabricated pipework shall be subject to a test to the Engineers satisfaction to ensure soundness before leaving the site of fabrication. Confirmation of the test results shall be provided within seven (7) days of the tests.

Prefabricated pipework shall be stored on site in such a manner so as to prevent damage to the pipework.

Prefabricated pipework shall be visually checked prior to installation by the Engineer or his appointed site representative for damage, defects, and correct method of fabrication. All pipework failing this inspection shall be corrected wholly at the Contractors expense.

C17.11 INSPECTION AND TESTING

Inspection

The Sub-Contractor shall be responsible for inspecting each stage of the works.

Full co-operation shall be maintained with the Local Authority.

A record shall be kept of the condition of any existing work which may be uncovered, any defects evident shall be pointed out immediately to the appropriate authority/departments representative.

Testing

Testing of the installation shall be carried out in two stages, the first test shall be by means of an air test equal to 65mm water gauge, and the second test equal to 38mm water gauge, and will remain constant for a period of not less than five minutes, applied as follows:

(a) First Test

On completion of the main soil vent stacks and installation of any branch pipes, all open ends shall be sealed off with a suitable drain plug.

At the foot of the stack or connection to the below ground drainage an air bag stopper shall be inserted into the stack or drainage connection via the removable access door.

A flexible tube shall be connected to one of the drain plugs with a tee piece and a cock on each branch of the tee piece fitted on the other end of the tube, one branch being connected by another flexible tube to a manometer.



(b) Second Test

On completion of the installation, i.e. when all sanitary fittings have been fixed, a second test shall be applied.

The water seals of all sanitary appliances shall be fully charged and test plug inserted into any open ends of the pipework to be tested and the test carried out as described above, but with an air pressure equal to 38mm water gauge. Alternatively, the connecting drain can be blanked off in the manhole and a water test can be applied by filling the pipework with water up to the flood level of the lowest sanitary appliance on that section of drain run.

(c) Records of Testing

Complete records shall be kept of all tests carried out during and on completion of the installation, and be available for inspection by the Services Engineer upon his request.

All tests on the sanitary pipework installation carried out by the Sub-Contractor, shall be recorded individually in a book for this purpose only.

The Contractor shall make these records available on site at all times and on completion of the contract, shall hand a duplicate copy of the test records to the Client.

Under no circumstances shall the whole installation be completed and then tested.

The installing Sub-Contractor shall give a minimum of 5 days notice in writing to all relevant bodies wishing to witness any test.

Any section of the above ground sanitary installation which fails any reasonable test shall be rectified wholly at the expense of the installing Sub-Contractor.

(d) Independent Testing

If required an independent final test of the whole of the works in this section shall be applied by the Officers of the Local Authority. The fact that any part of the work has passed this or previous tests will not relieve the Sub-Contractor of any of his obligations and any defects shown by the independent final test or appearing during the period of maintenance, shall be located and made good wholly at the Sub-Contractor's expense.

C17.12 GENERAL

The Contractor shall allow for providing 'as installed' drawings for all new services.



PART C - SECTION 18 ASBESTOS REMOVAL

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PART C - SECTION 18

ASBESTOS REMOVAL

C18.1 GENERAL

The Contractor/Sub-Contractor shall arrange for the whole of the works included in this section of the works to be completed by an Asbestos Removal Specialist.

The work shall be carried out in accordance with the requirements of :-

The Approved Code of Practice L28 'Work with asbestos insulation, asbestos coating and asbestos insulating board' as published by the Health and Safety Executive.

The Health and Safety at Work, and the like Act 1974.

The Control of Asbestos at Work Regulations 1987 and 1992 Amendments.

Control of pollution (Special Waste) Regulations 1980.

The Asbestos (Licensing) Regulations 1983.

The Management of Health & Safety at Work Regulations 1992.

Any subsequent amendments or additions to these requirements together with the requirements of the described work.

C18.2 PERSONAL PROTECTION

Respiratory Equipment :

Shall be of the 'High efficiency positive pressure type' in accordance with Certificate of Approval (Respiratory Protective Equipment) 1982 (revised), F. 2486-1982 (revised) and to BS4275, 'Recommendations for the Selection, Use and Maintenance of Respiratory Protective Equipment'.

The equipment shall fit the wearer correctly, and shall not be shared with other wearers unless adequately cleaned and disinfected beforehand.

Protective Clothing :

Shall be provided for all persons who are liable to contamination including supervisory officers, and shall be of a material which does not retain asbestos fibres.

Clothing and footwear must completely enclose the body, head and feet in such a manner as to prevent contamination.

Protective clothing shall be worn only in the working and 'dirty' areas and shall be of a different colour to clothing worn in transit between 'dirty' area and shower facilities.

No street clothes or footwear shall be worn on the 'dirty' (i.e. transit side) of the shower area and no transit clothing or footwear shall be worn on the 'clean' side of the shower area.



Personal Hygiene :

Shower units adequate in size and quantity for the number of persons requiring to use them shall be provided. Each unit shall have hot and cold water supplies, and filtered waste water outlets connected to soil drainage.

Soap, nail brushes, dry towels, hangers, hooks, storage lockers for respiratory equipment and protective clothing and personal lockers shall be provided in adequate quantities adjacent to shower units. A mirror for fitting respirators shall be positioned in the outer chamber of the airlock adjacent to the work area.

No towels shall be removed from site for 'home' laundering. They shall be bagged, sealed and sent to a laundry willing to clean asbestos contaminated clothing.

Shower facilities shall be sited between 'transit' and clean areas so as to deter users from retracing their steps from 'clean' to 'dirty' areas without having to pass through the washing facility.

Hygiene/Changing Procedure :

The following procedure shall be followed by all persons entering or leaving 'dirty' and working areas :-

Remove all street clothing and footwear in 'clean' end of shower facility.

Pass through shower area, not showering, enter 'dirty' end of facility ensuring air seals to 'clean' end is maintained.

Put on trunks, transit overalls and 'flip-flop' shoes.

Pick up clean respirator and walk to air lock at entrance of working area.

In first section of airlock put on respirator. Remove 'clean' transit overalls.

Pass to inner chamber of airlock. Put on 'work' clothes and footwear.

Proceed to work area.

On return from work area, vacuum off loose fibres from clothing and respirator (keep vacuum away from respirator filter and face piece of exhalation valve).

Go to inner chamber (work side) of air lock, remove all clothing and footwear except trunks and respirator. If clothing is contaminated, place in plastic bag so marked, squeeze out air and seal. Remove asbestos dust from outside of bag before sending to the laundry. Otherwise, bag, seal and hang clothing in this area.

Go to outer chamber of air lock, put on transit overalls and 'flip-flops'. Keep respirator on (except where passing through part of premises occupied by others) then place respirator in sealed plastic bag.

Go quickly to 'dirty' end of shower facility and close air lock. Remove clothing and place in store. Remove respirator and leave in 'dirty' end for cleaning.

Go quickly to shower area, shower, scrub and towel off. Go to clean area, close air lock, put on street clothes.



C18.3 SITE CONTROL

Site Preparation and Air Monitoring :

All walls, floors, fixed furniture and equipment within the working transit and shower areas shall be sealed against contamination by asbestos dust using plastic (PVC or polythene) sheeting securely sealed at all joints and laps. The ceiling in transit and shower areas shall also be sealed.

Plastic sheeting shall be used to form a triple air lock between working and transit areas and a double air lock between transit/shower facility and remainder of premises.

In all cases, working areas shall be completely sealed first.

Warning and prohibition notices shall be displayed outside all areas and only essential personnel shall enter shower/transit/working areas.

Fire escape routes shall be maintained and adequately signed.

Working, transit and shower areas shall be completely sealed from all other parts of the premises.

Lift shafts and ducts shall be double sealed against contamination by asbestos.

The enclosed work area shall be provided with air extraction equipment to reduce the levels of airborne dust, improve environmental conditions and to provide a slight negative air pressure to reduce the risk of dust escaping through from the enclosure.

The air extraction equipment shall be provided with high efficiency filters so that persons near the discharge point do not need respiratory protective equipment or protective clothing. The exhausted air shall be discharged to a point outside the building.

The air extraction equipment shall remain in operation for at least fifteen minutes after work in the area has ceased.

The effective sealing of the work areas shall be inspected and approved by the Services Engineer and/or the Health & Safety Executive Inspector prior to commencement of works.

On completion of the removal of the asbestos materials, the Asbestos Removal Specialist shall clean the area of the works to achieve a level of fibres not exceeding 0.01 fibres m.³ when sampled over a period of four hours. A certificate shall be issued by the Asbestos Removal Specialist recording the results of the final acceptance test.

The Health & Safety Inspectorate may arrange, at their own expense, for further tests to be undertaken, on completion of the contract works, to monitor that the areas are safe for re-occupation.

Removal of Asbestos :

The asbestos shall be removed by dry stripping by persons (over the age of eighteen years) who have been instructed in correct working procedures who are wearing respirators and protective clothing and who are maintaining all safeguards necessary for the safe removal of the asbestos.

Immediately upon stripping, the waste asbestos shall be bagged and sealed in impermeable durable plastic containers.



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Asbestos waste shall not be left lying around in the working area.

Where asbestos is being worked in restricted spaces, local high efficiency sealed extraction units shall be used.

Control of Asbestos Waste :

Rugged, sealed waste shall be transferred to the inner chamber of the triple air lock, where it shall be thoroughly vacuumed and cleaned down and placed in a second bag, sealed again and clearly marked 'asbestos waste'. This double bagged waste shall then be transferred to a suitable steel waste skip with a lockable steel lid, which shall be kept locked at all times if it is unattended. The waste shall subsequently be transported in the manner specified hereafter.

Any accidental spillage must be vacuumed up immediately and split bags further double bagged, sealed and marked.

Carriage of Waste :

Bagged waste shall be carefully transferred to sealed vehicles provided by the Asbestos Removal Specialist for transport to the tip specified.

Notification of Disposal of Asbestos :

The Asbestos Removal Specialist shall be regarded as the Producer of the waste and, therefore, the Pre-Notification Certificate and Description of the waste shall be given to the Waste Disposal Authority by the Asbestos Removal Specialist. The Asbestos Removal Specialist shall give 10 days notice to the Waste Disposal Authority of the date on which he will be removing asbestos from site. The Carrier's Collection Certificate shall be forwarded to the Asbestos Removal Specialist after completion of the Producer's Certificate and Description of the Waste.

The Asbestos Removal Specialist shall be responsible for ensuring that the Carrier's Collection Certificate is completed and for completing the Producer's Collection Certificate. Any necessary amendment to the Producer's Certificate and Description of the Waste should be made by the Asbestos Removal Specialist.

Disposal of Asbestos :

All asbestos shall be disposed of at Licensed Landfill Site as required by the control of Pollution Act 1974 and the Asbestos Removal Specialist should include for all charges connected therewith in his tender, and for carting thereto.

NOTE: ALL ASBESTOS WASTE INCLUDING ENCAPSULATED FORMS WHICH HAVE PREVIOUSLY BEEN CONSIDERED 'NON-SPECIAL' ARE NOW TO BE CONSIDERED 'SPECIAL' AND DISPOSED OF AS ABOVE.

Cleaning and Sealing of Structure after Removal of Asbestos :

After stripping, the area previously coated with asbestos, and the contaminated faces of protective sheeting, shall be thoroughly vacuumed to remove all loose fibres, followed immediately by an application of LPL solvent based metal primer (metal surfaces) or LPL Sealer (all other surfaces except woodwool) followed by a full coat of Decadex to firmly bond any remaining fibres to the surfaces stripped.



After sealing fibres, all protective sheeting shall be carefully removed, double bagged, sealed, marked and disposed of in the same manner as for asbestos waste. Care shall be taken not to re-contaminate any cleaned areas.

C18.4 MAINTENANCE OF PLANT AND EQUIPMENT

Personal Equipment :

Respiratory equipment shall be completely clean and fitted with a new filter before each shift, or at more frequent intervals if site conditions or manufacturer's recommendations require it, and shall be stored in clean and airtight containers when not in use.

Protective clothing shall be sent to a laundry capable of cleaning asbestos contaminated clothing, at least once every seven days or more frequently if the Services Engineer or the Health & Safety Executive Inspectorate requires.

Dirty clothing shall be double bagged, sealed and marked 'asbestos contaminated clothing' before dispatch.

Waterproof clothing may be cleaned by showering in the designated shower facility.

Shower waste filters shall be changed at the end of each shift and contaminated filters disposed of as for asbestos dust.

General Plant, Tools and Equipment :

All sheeting used to enclose working areas, air locks, transit area and shower facility shall be visually inspected at the start of each shift and any repairs carried out before works commence.

Smoke tests shall be carried out at the start of each shift to ensure that a negative air pressure is being maintained in the working space.

Filters on air extraction equipment shall be changed as required and contaminated filters disposed of as the asbestos waste.

All small plant and equipment used on the works shall have loose fibres removed by high efficiency vacuuming at least once per shift, contents of vacuum bags shall be disposed of as for asbestos waste.

No plant or equipment shall be removed from the work area until it has been cleaned within the work area and again within the inner air lock.

The Asbestos Removal Specialist shall nominate a person to be responsible for carrying out tests and inspection of sheeting, plant and equipment and keeping accurate records of dates and results of tests which shall be available for inspection by the Services Engineer and/or the Health & Safety Executive Inspectorate. Such tests shall be at intervals recommended by manufacturers/suppliers, or as required by the Services Engineer.

The person responsible shall also be conversant with repair and replacement procedures for the plant and equipment used on the works.



C18.5 ACCESS TO WORKING AREAS AND COMPLETION OF WORKS

The Asbestos Removal Specialist shall be allowed access to the works at all times during normal working hours, but special arrangements shall be made by the Contractor/Sub-Contractor if access is required outside these times.

No additional payment will be made for working outside normal working hours. Access shall be allowed to enable completion within the period specified in the Programme of Works.

C18.6 TEMPORARY ELECTRICAL SUPPLY AND LIGHTING

The permanent electricity supply to the working areas shall be cut off by the Contractor/Sub-Contractor prior to asbestos stripping. The Asbestos Removal Specialist shall, at his own expense, provide and maintain all temporary supplies for lighting, power tools, extraction equipment, transformers, wiring, and the like for the execution of the works.

C18.7 LIAISON

The Contractor/Sub-Contractor and Asbestos Removal Specialist shall work in close liaison and co-operate with any other Contractors involved with works associated with the Contract. They shall also work in close liaison and co-operation with the Clients' representative and the Services Engineer.

C18.8 PROGRAMME

The Contractor/Sub-Contractor shall present to the Services Engineer, at least seven working days before work commences, a programme giving exact start and finish dates. Where dates are included in the Specification, the Contractor/Sub-Contractor shall prepare his programme to comply with these dates.

The Contractor/Sub-Contractor and Asbestos Removal Specialist shall notify the Health & Safety Executive, twenty eight days prior to commencement of work (unless other arrangements agreed with the Services Engineer are made), when the work is programmed to start.

Where Blue Asbestos (Crocidolite) is to be removed, the Contractor and Asbestos Removal Specialist shall be responsible for giving 32 days notice to the Health & Safety Executive, and also the Client, of intent to commence work.

C18.9 PROTECTION OF EXISTING INSTALLATIONS

Care shall be taken to protect and leave in an undisturbed and sound condition the existing installation apart from the work specifically described.

Any disturbance to existing installations caused by the Asbestos Removal Specialist's work which results in damage to the installation shall be rectified at no cost to the Client.



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Any part of the installation found to be defective and in an apparent dangerous condition through no fault of the Asbestos Removal Specialist and not covered by this Specification, shall be drawn to the attention of the Services Engineer and rectified only on instruction.

Particular care shall be taken to ensure that dust, waste materials, water, and the like arising from the Asbestos Removal Specialist's work does not enter electrical equipment, gas and oil burners, pumps, furniture or materials stored or used in the area, and the like causing damage and subsequent hazards.

C18.10 LOOSE FURNITURE & EQUIPMENT, WALL BOARDS, VENETIAN BLINDS, CURTAINS, LIGHT FITTINGS AND THE LIKE

All loose furniture and equipment, wall boards, venetian blinds, curtains, lighting fittings, and the like shall be removed from the working areas prior to stripping work commencing and the cost of thoroughly cleaning all these items before removal from area, temporary protection, and for reinstating the items in their original position, shall be allowed for.

C18.11 INSPECTION

Every facility shall be afforded to the Services Engineer to examine the work during the period of the works. The Asbestos Removal Specialist shall make available one complete set of protective wear for use by the Services Engineer if the need should arise to enter any contaminated area.

The protective wear made available shall be appropriate to the type of asbestos being removed.



PART C – SECTION 21 MEDICAL GASES & VACUUM

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PART C – SECTION 21

MEDICAL GASES & VACUUM

C21.1 GENERAL

Medical Gas Installations shall comply with the Hospital Technical Memorandum 02, D.H.S.S. Publication WKO (82) 1, National Health Service Model Engineering Specification C11. COSHH Regulations 1999 And Safety Regulations 2000 and Works undertaken by an approved Specialist.

C21.2 PIPEWORK AND FITTINGS

Pipework shall be light gauge, phosphorous de-oxidised non-arsnetical copper to BS EN1412:1996 grade CW024A (CU-DHP) in metric outside diameters to:-

BS EN13348:2001 – R250 (Half hard) for sizes up to 54mm.

BS EN13348:2001 – R220 (Annealed) for larger sizes.

Manufacturers of pipework and fittings should comply with BS EN ISO9001: 2000.

Where materials are obtained from other countries the Suppliers should be registered in accordance with BS EN ISO9001:2000.

Pipe joint fittings should be end feed capillary fittings to BS EN 1254-1:1998. Fittings for connections between copper pipes and valves etc may be of copper, brass, gun metal, bronze or stainless steel.

All pipes delivered to size must be cleaned, degreased, individually capped at both ends and free of particulate matter and toxic residue in accordance with BS EN 13348:2001.

All pipe jointing fittings and sub-assemblies for connection to pipes must be cleaned, degreased, free from particulate matter, toxic residue and must be individually sealed in bags or boxes and clearly labelled:-

**“DEGREASED MATERIALS. FOR USE ON MEDICAL GAS INSTALLATIONS.
DO NOT ALLOW TO COME INTO CONTACT WITH OIL OR GREASE.”**

The Specialist Contractor shall take great care in storing these materials and any materials contaminated whilst on-site shall be returned to the manufacturer for degreasing, all at the expense of the Specialist Contractor.

If steam cleaning is not economical, pipes above 54mm outside diameter may be alternatively cleaned using an approved solvent such as methyl chloride, which will leave no poisonous or explosive residues and the fittings may also be cleaned by this method. The pipes and fittings shall be dried out, inspected and capped or sealed.



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While the degreasing process is primarily concerned with the bore of pipes, care shall be taken to avoid oil or grease on the outside as being a possible source for bore contamination.

- For pipe preparation the ends should be cut square on the pipe axis, only oil and grease-free tools and dies should be used.
- Brazed copper to copper joints should be made using silver copper-phosphorous brazing. Allow CP104 to BS EN 1044:1999 and no flux shall be allowed, brazing should be carried out using oxygen free nitrogen as an inert gas shield.
- Where pipe joints have to be made at break-ins to old pipeline systems, the use of purge gas (nitrogen) may be waived where existing joints would not have been carried out in accordance with the procedures laid down in HTM 02. This waiver must be agreed between the Health Facilities Manager or Trust Representative and the Specialist Pipeline Contractor.
- PTFE tape is not an acceptable sealing material for use on Medical Gas Systems, Downstream of Final Plant Filters, only liquid or gel-sealing compound should be used if they have been tested and proven safe when subjected to the tests specified in BS EN ISO 15001:2004.
- Where valves are fitted, the pipe shall be supported at both sides of the valve to facilitate valve operation without pipe movement.
- Fixing brackets or supports shall be of a suitable non-ferrous material or suitably treated to minimise corrosion and prevent electrolytic action.
- The Specialist Contractor shall drill and plug walls and ceilings as required to fasten the supports. Where roof decking is encountered the Specialist Contractor shall provide Cavity Fixing Devices to fasten the supports.
- Pipework in rooms and corridors shall be concealed either behind ceiling panels, or in walls or ducts. Pipework chased in walls shall be installed in one length from the Control Valve or Terminal Unit Tail Pipe to the Ceiling Void. The route of the buried pipe shall be clearly and continuously marked during construction, to discourage the driving of fixings into or near the pipe. Where pipes are to be installed in partition walls, the pipework from the Terminal Unit Tail Pipe to the Ceiling Void or Service Duct shall be continuous without a joint.
- Where pipes pass through floors, walls or partitions, copper sleeve pipes one size larger shall be built in by the Building Contractor, but supplied by the Specialist Contractor. Sleeves shall project between 1.5 mm and 3 mm beyond finished surfaces and plates shall be fitted. All joints shall be accessible and no joint shall be made so that it is inside the pipe sleeve.
- Where pipework is to be concealed, it shall not be covered over until it has satisfactorily passed all pressure tests.
- Pipework shall be supported at not greater than the intervals shown in the following table:



Spacing of Supports for Copper Pipes

Nominal Pipe Outside Diameter mm	Maximum Intervals for Vertical Runs Metres	Minimum Intervals for Horizontal Runs Metres
12	1.5	1.5
15	1.5	1.5
22	2.0	2.0
28	2.0	2.0
35	2.5	2.5
42	2.5	2.5
54	2.5	2.5
76.1 and above	3.0	3.0

Great care shall be taken during installation to ensure that no extraneous materials are allowed to enter the pipework. Where any section is left incomplete during erection, the open end of the pipe shall be sealed immediately.

Wherever possible, pipelines shall be physically separated from the metal sheath and armour of electric cables and from metal conduits, ducts, trunking and bare earth continuity conductors associated with any cables which operate at low voltage or above. Where physical separation is impossible or when pipelines are in metal trunking and bedhead units, the pipelines shall be bonded to the metal work to BS 7671:2008. The entire pipework system for each service shall be earthed by bonding to the nearest Consumer's Earth Terminal, in accordance with BS 7671:2008. In all cases, bonding and/or earthing of Medical Gases Pipework will be the responsibility of the Electrical Sub-Contractor who shall install the bonding to details supplied by the Specialist Sub-Contractor.

Following installation, pipelines shall be clearly identified with 150mm wide adhesive labels. Labels shall be fitted near walls, risers, valves, junctions and at 3.0m spacing on straight lengths all bearing 6mm size letters identifying each gas service. Colour coding and labelling shall be in accordance with BS 1710 : 1984.



C21.3 VALVES ON DISTRIBUTION PIPEWORK

Line Ball Valves c/w NISTS

Medical Gas Line Ball Valves complete with lockable NIST connections and blanking spade shall be provided as a means of isolation on Medical Gas Pipelines at positions specified in the Medical Gas Pipeline System design. Line Ball Valves assemblies shall comply with NHS Health Technical Memorandum 02-01 (HTM02-01). Valves shall operate from the fully open to the fully closed position by manual operations of a lever through 90°. Valve nominal bores shall be equal to the nominal pipework size.

All Line Ball Valves shall be cleaned for oxygen service. Smaller type V assemblies (15mm to 54mm inclusive) shall have flat-face connectors with 'O' ring seals. The larger VF type (76mm to 108 mm inclusive) shall be flanged and installed with stainless steel bolts, nuts and spring washers with 3mm Viton® sealing gaskets. PTFE tape or any other thread sealing media is not acceptable.

Each Medical Gas Line Ball Valve assembly shall terminate in copper stub pipes to enable brazing direct into the distribution system using the flux less brazing technique. Valve assemblies shall incorporate a sliding lock mechanism on the handle, which can be locked in either the open or closed position using a standard padlock with a 6mm (1/4") diameter shackle. NIST blanking nuts shall be capable of being padlocked onto the NIST bodies.

There should be sufficient padlock/key type combinations available to provide a single key type per gas service to enable the locking and unlocking of NIST caps. The key type should be standardised across the installation and valves should be manufactured and supplied with appropriate key/padlock combinations.

Materials

Medical Gas Line Ball Valve assemblies shall be constructed in a two-piece full-bore design with nickel-plated brass body, Teflon® ball seals, stem packing seal, stem 'O' ring seal and a hard-chrome plated brass ball. Valves shall be designed to have a tight shut-off and blow out proof stem for protection against pressure surges. Copper stub pipes shall be manufactured from medical grade copper pipe to BS EN 13348:2001. Copper stub pipes shall be of sufficient length to enable brazing directly into the distribution system without the need for disassembly on site.

Ball valves up to 54mm nominal bore shall be supplied from the manufacturer in robust cardboard packaging to prevent damage during transit.

Testing

All Ball Valve assemblies shall be pressure tested for valve tightness and leakage prior to packing and shipping.

CE Marking

Line Ball Valves should be 'CE' marking under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as class IIb Medical Devices. Certificates should be provided.



C21.4 VALVE BOXES

Area Valve Service Unit

The AVSU shall conform to BS EN 739:1998, HTM 02 and BS EN 737-3:1998. The AVSU shall provide a zone isolation facility, for use either in an emergency or for maintenance purposes. It shall also provide a physical breakpoint to allow work to be safely carried out on the pipeline. A red coloured physical barrier (spade) shall be capable of insertion when required on either side of the valve, without the need to totally dismantle the line valve. During normal service, full-flow gaskets with an 'O' ring groove on one side shall be coloured white and provide sealing between the flat face connector and ball valve. The line valve shall be brass 22mm or 28mm ball valve with PTFE seals/seats, operated by a quarter turn handle with over-travel prevention in both directions. The Ball Valve shall connect by 22mm or 28mm copper stub pipes to the distribution system. The assembly shall be housed in a valve box, which shall be capable of both surface and concealed installation. The box shall be made from extruded aluminium with die-cast aluminium end caps to prevent corrosion, offer high strength and resist high temperatures from blazing in close proximity. The box shall be finished in RAL 9010 polyester powder coat finish. A hinged door shall lock in the closed position and AVSU's installed adjacent to each other shall be operated by different key/lock combinations. The AVSU door shall open through a minimum of 160° to provide maximum access and provide for natural ventilation to prevent build up of gas within the valve box. A blank zone identification label shall be provided with each AVSU 2nd fix assembly. Each AVSU assembly shall be factory tested for gas tightness.

Emergency Access

The 2nd fix shall include a transparent plastic window incorporating the words 'Pull in Emergency and Close Valve'. In order to gain access in an emergency, a ring pull shall be fitted to the removable portion of the window. Glass windows shall not be used. It shall not be possible to refit or reset the means of emergency access.

Door Tamper Alarm

A Door Tamper Alarm Facility shall be available, with a reed switch initiating a system alarm indication on the local alarm panel when the emergency access window is removed. Normally only oxygen and medical air AVSU's controlling high acuity care areas, resuscitation bays and accident and emergency wards shall be fitted with the door tamper facility. Wiring between the door and area alarm panel shall be carried out by the electrical contractor.

Materials

The second fix assembly shall be manufactured from fire retardant V0 rated ABS. All wetted parts (except seals and gaskets) shall be brass or copper. Copper stub pipes shall be manufactured from phosphorous de-oxidised non-arsenical copper to EN 1412:1996 grade CW024A, manufactured to metric outside diameters in accordance with EN 13348:2001 R250 (half hard). Rubber pipe grommets shall be provided to ensure any leaking gas does not escape from the box into a wall cavity. All elastomeric gas seals shall be manufactured from Viton with a Shore hardness of 75. Mild steel components shall not be used. Sacrificial protection (e.g. galvanising), passivation or painting shall not be used to provide corrosion protection. Materials shall be inherently resistant to corrosion.



Gas Specific Connections

The AVSU shall be fully gas specific and labelled to identify the Medical Gas Service. The gas specific shrouds shall clearly show the gas service and use colour coding to BS EN 739. Shrouds shall be pin indexed such that only the correct shroud can be fitted to each 1st fix. Gas specific NIST connections to BS EN 739:1998 shall be incorporated on each side of the line valve include a permanently fitted gas identification label. Pressure gas service (not vacuum) NIST connections shall incorporate 100% self-sealing valves which, held closed by gas pressure until insertion of the appropriate gas specific male NIST fitting.

Local Alarm Pressure Switches

The AVSU shall incorporate minimum leak pressure switch connection ports on the left and right-hand sides to enable installation of a line pressure switch inside the box.

CE Marking

Area Valve Service Units should be 'CE' marked under the Medical Devices Directive 93/94/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

C21.5 TERMINAL UNITS

The Medical Gas Terminal Units shall conform to EN 737-1:1998 and accept probes to BS 5682:1984. Terminal units shall be capable of single-handed insertion and removal of the medical gas probe. The Anaesthetic Gas Scavenging (AGS) terminal unit shall conform to BS 6834:1987. The wall mounted first fix assembly shall consist of brass pipeline termination block with copper stub pipe secured between a back plate and a gas specific plate to allow limited radial movement of the copper stub to align with the pipeline. The gas specific plate shall be permanently fixed to the backplate by means of tamperproof screws locked in position with an anaerobic curing adhesive. The first fix shall incorporate a maintenance valve (except for vacuum) and a test plug. The test plug shall provide an effective blank to enable carcass pressure testing. The second fix plastic components shall be manufactured with the pin index permanently moulded into the gas specific socket. The socket assembly shall retain a capsule assembly, containing the check valve and probe 'o' ring seals. The replaceable capsule assembly shall enable all working parts subject to wear through usage to be replaced as a factory tested assembly, thereby reducing maintenance time. Each termination block assembly shall be pressure tested by the pressure decay method.

Gas Specific

Terminal units shall be gas specific and only accept the correct medical gas probe. Gas specific components shall be pin-indexed to ensure that a correct gas specific assembly is achieved so that in normal course of dismantling for repair or maintenance, parts from other gases cannot inadvertently be used. Wall mounted terminal units shall incorporate an anti-rotation pin to engage with connected downstream medical equipment ensuring correct orientation.



Materials

All screws, probe roller pins, locking springs and the anti-rotation pin shall be manufactured from stainless steel. The second fix assembly shall be incorporating three injection moulded parts in fire-retardant nylon 66. All wetted parts (except seals) shall be brass or copper. Copper stub pipes shall be manufactured from phosphorous de-oxidised non-arsenical copper to EN 1412:1996 grade CW024A, manufactured to metric outside diameters in accordance with EN 13348:2001 R250 (half hard). All elastomeric seals shall be manufactured from Viton with a Shore hardness of 75.

Pipeline Connections

Terminal units installed in walls, bedhead trunking, headwalls or fixed pendants shall be connected to the pipeline with a copper stub pipe. Pressure gases and vacuum shall incorporate a 12 mm copper stub pipe with a swagged end for direct connection to a 12 mm O/D copper tube without the need for an extra fitting, thereby requiring only a single brazed joint to be made. Terminal units for Anaesthetic Gas Scavenging shall incorporate a 15 mm O/D copper stub pipe.

Terminal units installed in booms or moveable pendants shall be attached to their respective flexible gas hose by a gas specific non-interchangeable screw thread (NIST) fitting to BS EN 739:1998. Terminal units shall be fitted with a male NIST and nut for connection to hoses with a female NIST connection.

Terminal units shall be installed and connected to the distribution pipework in accordance with the drawings and installed when facing the units mounted in the following order from left to right:-

Oxygen, Nitrous Oxide, Entonox, Medical Air, Surgical Air, Vacuum, AGS, Heliox.

C21.6 PENDANTS

The Pendant shall be designed for installation into operating theatres, anaesthetic rooms and critical care areas providing medical gases, electrical power, data and extra low voltage services as listed in the schedule of technical requirements. The Pendant shall be supplied pre-piped, pre-wired and fully tested. Pendants shall be manufactured and installed to provide a 2000 mm clearance above finished floor level (in retracted position for retractable pendants). The pendant shall fully comply with HTM02, NHS Model Engineering Specification C11, BS EN ISO 11197:2004 and the IEE Wiring Regulations.

The Pendants shall be capable of mounting up to 8 medical gas/vacuum terminal units plus an anaesthetic gas scavenging terminal unit, along with 8 double gang and 8 single gang electric sockets/devices. Medical gas/vacuum services shall incorporate terminal units and the anaesthetic gas scavenging disposal system shall incorporate a terminal unit to BS 6834:1987. Medical gas/vacuum services shall be arranged in accordance with HTM02 recommendations. Electrical installations shall conform to the IEE Wiring Regulations and BS EN ISO 11197:2004, routed through flexible conduit and terminate in a junction box.



Rigid Pendant

The Rigid Pendant shall be rigidly piped in accordance with the requirements of BS EN ISO 11197:2004. Flexible hose assemblies shall not be used. The compartment for housing medical gas pipes shall be capable of running up to 9 gas pipes generously spaced to facilitate simple on-site brazing to the piped distribution system. Copper pipes shall be manufactured from phosphorous de-oxidised non-arsenical copper to BS EN 1412:1996 grade CW024A and be manufactured to metric outside diameters in accordance with a BS EN 13348:2001 R250 (half hard).

Retractable Pendant

The Retractable Pendant shall be supplied with colour coded flexible hoses to BS EN 739:1998 with the appropriate NIST fittings permanently attached. Pressure gas systems shall incorporate a self-closing check valve in the 1st fix termination to enable hose replacement without disruption of the system.

The Retractable Pendant shall extend and retract through a vertical range of 300 mm at an approximate rate of 20 mm/s and shall be powered by a single-phase linear actuator. The linear actuator shall operate from a 230FV, 50 Hz electrical power supply fused at 5A. An extra-low voltage (12V) remote hand controller shall operate the pendant and internal micro-switches shall break the control circuit at the limits of travel. Thermal overload protection shall be incorporated within the linear actuator control circuits.

CE Marking

Rigid and Retractable Pendants should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, specified products are classified as Class IIb Medical Devices. Certificates should be provided.

Articulated Pendant Systems

The Pendant system shall provide a safe, robust and ergonomic medical workplace solution. The pendants shall be designed to comply with HTM 02-01, BS EN 60601-1 and ISO 11197.

It shall be possible to replace all medical gas hoses without the need for on-site crimping of ferrules. All medical gas hoses shall be colour coded to BS EN 739. Non-colour coded hoses or hoses without permanently crimped connections are not acceptable.

Bearings

High quality bearings shall be used to provide smooth and free movement, minimising the force required to overcome static friction forces during repositioning. Bearings shall be permanently lubricated and sealed, with no maintenance or replacement necessary. All bearings shall be supplied with a 5-year warranty.

Pendant Arms

Pendant arms other than the cantilever lift arm shall be manufactured from extruded aluminium sections and will be manufactured in various lengths. External surfaces of all arms shall be polyester powder coated in a RAL 9002 finish. Arm end caps shall be manufactured from moulded polyflam with a UL listed fire retardancy of UL94/VO.



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Tandem pendants for critical care areas shall be designed so that the consoles can readily swap sides within the bed bay to maximise the flexibility of the workspace.

Cantilever lift arms shall be driven by a single phase AC induction motor with power transmitted to the cantilever mechanism by a ball screw. Linear actuators shall not be used in the vertical lift mechanism for the pendant console. When tested to BS EN ISO 3744, the sound pressure level produced by the cantilever vertical lift mechanism shall not exceed 30dB(A).

The sides of the arms shall be provided with plastic finishing strips to compliment the modern practice of colour coding bed bays in critical care areas as a visual reminder to aid infection control policy.

Rotation Control

The Pendant shall be provided with active pneumatic brakes at each rotating arm joint. Articulated pendants (double arms) shall have independently controlled brakes to enable control of arm movement.

The Pendant console brake shall be operated from the same pneumatic control switch as the lower arm joint where articulated (double) arms are fitted. Pendants with cantilever vertical lift shall not be fitted with pneumatic brakes in the joint connecting to the console. Non-return valves shall be fitted downstream of the connection to the medical/surgical air pipeline to prevent back-flow in the event of low distribution system pressure.

The arms shall be capable of 340° of rotation. Infinitely variable rotational stops shall enable precise off limits travel to be set to ensure maximum freedom of movement, whilst protecting walls and ancillary equipment. The rotational stops shall be dampened such that when limit of travel is reached, sensitive suspended equipment is not subjected to shock or vibration as the kinetic energy is absorbed.

Console

Consoles shall be manufactured from extruded hard-anodised aluminium sections, with polyester powder coated (RAL 9002) aluminium fascia plates. Consoles shall be available in lengths from 200 mm to 1000 mm increments to suit the number of services and equipment supports required.

CE Marking

Pendant systems should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.



C21.7 WASTE ANAESTHETIC GAS SYSTEM

Anaesthetic Gas Scavenging Disposal System – BS 6834:1984

The Anaesthetic Gas Scavenging (AGS) System shall comply with HTM2022 and BS 6834. The AGS system shall be a dedicated, specifically designed active extraction and disposal system for waste anaesthetic gas. It shall provide a maximum flow rate of 130 l/min with a 1 kPa resistance to flow and a minimum of 80 l/min with a 4 kPa resistance to flow at each terminal unit, irrespective of the number of terminal units in use. The AGS system shall use dedicated radial blowers in a simplex or duplex configuration, in accordance with the schedule of technical requirements.

The AGS pump assemblies shall be skid mounted and included on the skid shall be the simplex or duplex pump(s), motor control units(s) with starter/isolator, moisture drain flask and flexible connector(s) to connect the plant to the pipeline. Each pump shall include an electric motor and directly coupled impeller assembly. Impeller bearings in the pump(s) shall not require lubrication. The pump(s) shall be air cooled and rated for continuous operation.

Vacuum/Flow Regulating Valve

A vacuum/flow regulating valve shall be provided, comprised of a spring-loaded plate valve and inlet silencer. The plate shall control air ingress into the pipeline system, thereby controlling the vacuum level within. The vacuum/flow regulating valve shall ensure a maximum vacuum of 200 mb below atmospheric pressure is not exceeded.

Control System

Each motor control panel shall incorporate an emergency panel isolation switch facility, which controls all electrical power to the exhaustor unit, remote start switch panels and system indication lights. All control and status indication circuitry shall be limited to 24V a.c. A green 'POWER ON' indicator shall be fitted to the starter/isolator panel and shall illuminate whenever power is available to the 24V control and indication circuit. A 'HAND/OFF/AUTO' switch shall be provided to control operation of the pump, running the pump continuously when selected to 'HAND'. When selected to 'AUTO', control of the pump shall be passed to the remote start switch panels. Operation of any of the remote start switches shall activate the pump. The pump shall continue to run until all remote switches are selected 'OFF'.

The starter/isolator panel shall incorporate a thermal protection overload device. The thermal protection overload device shall also monitor the electrical power supply and phase input. In the event of a fault, the overload device shall break the circuit to the pump, preventing operation until the system is manually re-set. Operation of the overload device shall also break the circuit to the remote start switch panels, extinguishing the green running indicator.

Simplex starter/isolator panels c/w alarm pressure switch and duplex units incorporate line pressure switch. The line pressure switch monitors vacuum levels and provides an additional control of the remote start switch and starter/isolator panel green 'RUNNING' indicators.



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Simplex installations with a pressure switch on the pump assembly shall use remote start switches that include a red 'PLANT EMERGENCY' indicator. This indicator shall illuminate on all remote start switch panels if the vacuum level falls below the pressure switch set point level when the pump has been called, or if the overload trips.

Duplex installations shall use remote start switches that include an amber 'PLANT FAULT' indicator. This shall illuminate, if either pump is set to 'HAND', or if one of the overloads trip. A red 'PLANT EMERGENCY' indicator shall also be provided and shall illuminate on all remote start switch panels if the vacuum level falls below the pressure switch set point level when the pump has been called.

Where a duplex system is installed each pump shall be controlled by a separate motor control panel to enable servicing of either pump or control gear whilst maintaining system operation.

Remote switch panels shall be installed at locations identified on the drawings.

All interconnecting wiring between the remote panels and the AGS pumps shall be carried out by the Electrical Contractor.

CE Marking

AGS Pump Assemblies and Terminal Units should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

C21.8 BEDHEAD TRUNKING

Where indicated on the drawings a Trunking system to contain the Bedhead Services will be installed by the Electrical Contractor.

The Trunking system will incorporate three compartments with one section allocated to contain the medical gas pipelines. The opening in the trunking system to contain the terminal units will be formed by the Electrical Contractor to the requirements provided in this contract.

The Bedhead Trunking system should be 'CE' marked under the Medical Devices Directive 93/42/EEC, under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

C21.9 LIQUID OXYGEN PLANT

The Oxygen supply to the distribution system shall be from a Medical Liquid Oxygen Plant which shall be installed by a Specialist Oxygen Supplier under a separate Contract.

The Sub-Contractor's work shall commence at the valved distribution point installed by the Specialist Oxygen Supplier within the Liquid Oxygen Plant Compound.



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The work shall comprise the supply and installation of a Medical Liquid Oxygen Plant at the position shown on the drawings.

The plant shall be of the vacuum insulated evaporator type and have a capacity equal to the appropriate simultaneous demand.

The plant shall include a standby oxygen twin manifold which shall come into operation immediately the liquid plant ceases to operate.

The manifold assembly shall also remain the property and responsibility of the Specialist Supplier as regards regular inspection and maintenance but daily running of manifold and replacement of cylinders as required shall be the responsibility of the Health Authority.

The Oxygen supply to the distribution system shall be from a Medical Liquid Oxygen Plant which shall be installed and commissioned by a Specialist Liquid Oxygen Supplier under a separate contract to the Medical Gas Specialist Contract.

The installation shall be as described in the standard specification, description of works (Part D)

C21.10 MANIFOLD SUPPLY SYSTEMS

The Manifold Control System shall conform to NHS Health Technical Memorandum No. 02-01 (HTM02-01) and NHS Model Engineering Specification C11. The Manifold Control System shall provide an uninterrupted supply of a Specific Medical Gas from equally sized high pressure cylinder banks via a suitable arrangement of pressure regulators, providing a constant downstream nominal pipeline gauge pressure of 400 kPa, 700 kPa or 1100 kPa. The entire system shall be 'duplexed' such that any single functional component failure will not affect the integrity of the medical gas supply. The manifold shall be supplied fully assembled and tested.

Manifold Control System Design

There shall be two separate stages of regulation to enable high peak flow rates without a reduction in line pressure. Multistage regulators combined into a single unit are not acceptable. Regulators shall comply with BS EN ISO 10524-2 and shall have documented test reports available confirming successful completion of the oxygen ignition tests stated therein. The manifold control system shall be capable of supplying a flow of 1000 l/min to a 400 kPa distribution system and a flow of 2000 l/min to a 700 kPa distribution system.

In order to comply with HTM 02-01, BS EN 10524-2, BS EN ISO 15001 and BS EN ISO 14971, high pressure cylinder manifolds (>3000 kPa) containing polymers directly in the gas stream (such as seats and diaphragms of pressure regulators) shall be manufactured from non-hydrocarbon based peroxide cured plasticiser is an example of one acceptable material. Manifold and line pressure regulators shall comply with BS EN ISO 10524-2 and be supplied with appropriate auto-ignition test results. Non-return valves in manifold header systems shall incorporate brass seats and ceramic balls.



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All regulators shall be protected from over-pressurisation by relief valves that are vented to atmosphere. There shall be a bypass valve fitted across to the 2nd stage relief valve to enable gas to be vented outside the manifold room during the commissioning stage. A test point (supplied separately) shall be isolated from the supply with a 15 mm ball valve. The manifold shall be supplied with a non-return valve for connection to the distribution system.

The Control Panel shall be housed in a single panel having a solid construction using epoxy technology in a glass-reinforced polymer moulding for high chemical and corrosion resistance high impact strength. The cover shall hinge upwards but shall remain facing outward for manual operation and maintenance accessibility. To aid maintenance the connections within the panel shall be 'O' rings sealing against flat-face connectors to facilitate easy removal and replacement of components.

For added safety the voltage inside the panel shall not exceed 12V D.C. The mains supply transformer shall be in its own housing in a moulded recess at the rear of the panel. To simplify installation there shall be an installation bracket attached to the wall with four screws, the main panel then shall locate onto this bracket and be secured.

Control System Operation

Either the left or right hand manifold bank may be designated "Duty" and the manifold control system shall automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a pre-determined level. Each side of the manifold control system shall be capable of being fully isolated via a full flow ball valve in order to change any regulator without cessation of supply. The inlet of the 1st stage regulator shall be protected from the particulate matter by a 25 mm sintered bronze filter.

There shall be a fail safe system in the event of power failure so that solenoid valves open and there is full continuity of supply pressure and flow. Upon power restoration the unit shall revert back to the original bank of cylinders being used. To avoid inadvertent resetting to the change cylinder alarm the solenoid valves shall be latched so that once changeover has occurred and the cylinders have been replaced, a reset button must be operated to cancel the alarm condition.

There shall be manual changeover buttons so that servicing either side of the system can be simply achieved. The PCB's shall be linked with plug and socket connectors for easy removal.

Manifold relief valves are to be coupled to copper vent pipes one size larger than the distribution pipe and vented to atmosphere at a suitable level and positioned outside the building. The end of the vent pipe shall terminate in an inverted 'U' bend with guard. The discharge point shall be finally agreed on-site by the Services Engineer and This Section of the Works to ensure that there is no danger of fire, injury to personnel, contamination or interference to air intakes or windows. The safety valve and vent pipe shall be supplied and installed in a degreased condition. Weatherproof notices shall be fixed at each discharge point stating:-

"DANGER KEEP CLEAR. MEDICAL GAS DISCHARGE POINT"



The supporting steelwork for the cylinders on each manifold shall hold them against the wall and shall consist of mild steel bulb angle section with neatly formed semi-circular cut outs to space and support the cylinders in the banks. All securing bolts shall be provided, drilled and fixed by the Specialist Contractor.

CE Marking

Manifold Control Systems should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

The Specialist Medical Gas Contractor shall supply duplicate wiring diagrams and instructions within four weeks of being awarded the Contract.

C21.11 MEDICAL COMPRESSED AIR (4 BAR) PLANT

The Medical Air Plant shall conform to NHS Health Technical Memorandum HTM02 Medical quality air to the European Pharmacopoeia monograph shall be delivered at a pressure of 400 kPa (4 bar) gauge for supply of the hospital medical air system. The entire system shall be 'duplexed' such that any single functional component failure will not affect the integrity of the medical compressed air supply. Duplex, triplex or quadraplex configurations will produce the primary supply from 2 compressors. Each compressor will be capable of supplying the specified volumetric flow for duplex and triplex plant and half flow for quadraplex. For duplex plant the secondary supply shall be from an automatic manifold capable of supplying at average demand for 4 hours. For triplex and quadraplex plant the standby compressors will be the secondary supply.

Compressors

Compressors shall be oil injected rotary screw compressors suitable for both continuous and frequent start/stop operation at a nominal outlet pressure of 950 kPa gauge (9.5 bar). Compressors shall be supplied with a block and fin style aftercooler with a dedicated quiet running fan to maximise cooling and efficiency. A multi-stage oil separator capable of achieving 2 ppm oil carry over shall be fitted to minimise contamination and maintenance. EFF1 (CEMEP) rated TEFC, IP55 class F electric motors shall be used and incorporate maintenance-free greased for life bearings. Motors with lower efficiency ratings are not acceptable. Each screw compressor shall be supplied with an intelligent user interface to digitally display service and warning indications, working pressure, operating temperatures, number of motor starts, on-load running hours and total running hours.

Dryer/Filter/Regulator Systems

The duplexed filter and dryer module shall incorporate high efficiency water separators, oil filters, heatless regenerative desiccant dryer, dust/activated carbon filters, hopcalite filters and bacterial filters with autoclavable element.



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Contaminants in the delivered air downstream of the bacterial filters shall be maintained at levels below those shown in the following table:-

Contaminant	Threshold
H ₂ O	67 ppm v/v
Dry Particulates	Free from visible particulates in a 751 sample
Oil (droplet or mist)	0.1 mg/m ³
CO	5 ppm v/v
CO ₂	500 ppm v/v
SO ₂	1 ppm v/v
NO	2 ppm v/v
NO ₂	2 ppm v/v

The dryer control system shall incorporate an Energy Management system that shuts off purge air when no compressors are running.

Control System

The Central Control Panel shall operate at extra low voltage and include BMS connections for plant fault, plant emergency, reserve fault and pressure fault. A mechanical back-up facility shall ensure continued operation in the event of malfunction. The Control System shall normally employ automatic rotation of lead compressor to maximise compressor life and ensure even wear.

Receiver Assembly

Air receivers shall comply with BS EN 286-1:1992 Class 2 Grade C (>10,000 bar litres) or BS EN 286-1:1998 Class 1 (<10,000 bar litres), supplied with relevant test certificates. Receiver volume shall be at least 50% of the plant capacity in 1 minute in terms of free air delivered at normal working pressure. Receivers shall be fitted with an electronic automatic drain valve. Float type drain valves are not acceptable. Single receivers shall only be fitted to provide non-interrupted supply during vessel inspections/maintenance. The receiver assembly shall be fitted with a pressure safety valve capable of passing the maximum flow output of all compressors at 10% receiver overpressure. The receiver shall be further protected by a fusible plug and include a pressure gauge.

Dew Point Monitoring

The dryer shall incorporate a ceramic dew point hygrometer with an accuracy of $\pm 1^{\circ}\text{C}$ in the range -20 to -80°C atmospheric dew point to 4-20 mA analogue output. Aluminium oxide or palladium wire sensors are not acceptable. An alarm condition shall trigger on the dryer control panel if the dew point exceeds a -46°C atmospheric set point. The dryer control unit shall incorporate a 7-segment LED, continually displaying the dew point of the delivered air to enable monitoring of the air quality by the hospitals estates department. Volt free contacts shall be included to enable the dew point alarm signal to be connected to a central medical gas alarm system and/or Building Management System (BMS). To enable periodic calibration of the dew point sensor element, the hygrometer shall be remotely connected downstream of the dryer via a micro-bore tube. It is not acceptable to install the sensor directly into the medical air supply pipeline.



CE Marking

Medical Air Plant should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

Maintenance

The plant shall be arranged to facilitate easy and efficient inspection and maintenance.

Builder's Work

The Specialist Contractor shall supply and fix all holding-down bolts and anti-vibration mountings for the compressor plant installed in his sub-contract and shall supply details of all foundations and hole positions for the Building Contractor to provide. The concrete foundation block, if required, shall be of adequate mass placed on suitable resilient foundations to damp out vibrations.

Electrical Installation Work

All electrical equipment shall be supplied and installed by the Specialist Medical Gases Contractor.

The interconnecting wiring shall be carried out by the Electrical Contractor to details provided by the Specialist Contractor.

The Specialist Medical Gases Contractor shall supply duplicate wiring diagrams and instructions within four weeks of being awarded the contract.

C21.12 SURGICAL COMPRESSED AIR (11 BAR) PLANT

The Surgical Air Plant shall conform to NHS Health Technical Memorandum No. 02-01 (HTM02-01). Medical quality air shall be delivered at a pressure of 1100 kPa (11 bar) gauge to enable supply of the hospitals surgical air system.

Compressor

The Compressor/s shall be oil injected rotary screw compressor/s suitable for both continuous and frequent start/stop operation at a nominal outlet pressure of 1300 kPa gauge (13 bar). The compressor/s shall be supplied with a block and fin style aftercooler with a dedicated quiet running fan to maximise cooling and efficiency. A multi-stage oil separator capable of achieving 2 ppm oil carry over shall be fitted to minimise contamination and maintenance. An EFF1 (CEMEP) rated TEFC, IP55 Class F electric motor/s shall be used and incorporated maintenance-free greased for life bearing. Motors with lower efficiency ratings are not acceptable. The screw compressor/s shall be supplied with a digital display for service and warning indications, working pressure, operating temperature, number of motor starts, on-load running hours and total running hours. The compressor is sized in relation to the hospitals calculated Design Flow (DF) using the multiplying factors shown in the table below:-



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Simplex Surgical Air Compressor System	Design Flow (l/Min)	Compressor FAD
	<500	0.33 x DF
	500-3500	0.66 x DF
	>3500	0.75 x DF

Dryer/Filter/Regulator System

The Filter and Dryer Module shall incorporate a high efficiency water separators oil filter, heatless regenerative desiccant dryer, dust/activated carbon filter and bacterial filter with autoclavable element. Contaminants in the delivered air downstream of the bacterial filter shall be maintained at a level below those shown in the following table:-

Contaminant	Threshold
H ₂ O	67 ppm v/v
Dry Particulates	Free from visible particulates in a 751 sample
Oil (droplet or mist)	0.1 mg/m ³
CO	5 ppm v/v
CO ₂	500 ppm v/v
SO ₂	1 ppm v/v
NO	2 ppm v/v
NO ₂	2 ppm v/v

The Dryer Control System shall incorporate an Energy Management System that shuts off purge air when the compressor/s is not running.

Control System

The Control Panel shall include BMS connections for plant fault, plant emergency and pressure fault. A mechanical back-up facility shall ensure continued operation in the event of malfunction.

Receiver Assembly

Air receivers shall comply with BS EN 286-1:1992 Class 2 Grade C (>10,000 bar litres) or BS EN 286-1:1998 Class 1 (<10,000 bar litres), supplied with relevant test certificates. Receiver volume shall be at least 50% of the plant capacity in 1 minute in terms of free air delivered at normal working pressure. Receivers shall be fitted with an electronic automatic drain valve. Float type drain valves are not acceptable. Where only a single receiver is supplied by –pass valves shall be fitted to provide interrupted supply during vessel inspections/maintenance. The receiver assembly shall be fitted with a pressure safety valve capable of passing the maximum flow output of all compressors at 10% receiver overpressure. The receiver shall be further protected by a fusible plug and include a pressure gauge.



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The receiver is sized in relation to the hospitals calculated Design Flow (DF) using the multiplying factors shown in the table below:-

Simplex Surgical Air Receivers	Design Flow (l/Min)	Receiver water capacity
	<500	1 x 2 x DF
	500-3500	2 x 2/3 x DF
	>3500	3 x 1/3 x DF

Dew Point Monitoring

The Stryer shall incorporate a ceramic dew point hygrometer with an accuracy of $\pm 1^{\circ}\text{C}$ in the range -20 to -80°C atmospheric dew point and 4-20 mA analogue output. Aluminium oxide or palladium wire sensors are not acceptable. An alarm condition shall trigger on the dryer control panel if the dew point exceeds a -46°C atmospheric set point. The dryer control unit shall incorporate a 7-segment LED, continually displaying the dew point of the delivered air to enable monitoring of the air quality by the hospitals estates department. Volt free contacts shall be included to enable the dew point alarm signal (plant emergency) to be connected to a central medical gas alarm system and/or Building Management System (BMS). To enable periodic calibration of the dew point sensor element, the hygrometer shall be remotely connected downstream of the dryer via a micro-bore tube. It is not acceptable to install the sensor directly into the medical air supply pipeline.

CE Marking

Surgical Air Plant should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

Maintenance

The Plant shall be arranged to facilitate easy and efficient inspection and maintenance.

Builder's Work

The Specialist Contactor Shall supply and fix all holding-down bolts and anti-vibration mountings for the compressor plant installed in his sub-contact and shall supply details of all foundations and hole positions for the Building Contractor to provide. The concrete foundation block, if required, shall be of adequate mass placed on suitable resilient foundations to damp out vibrations.

Electrical Installation Work

All electrical equipment shall be supplied and installed by the Specialist Medical Gases Contractor.

The interconnecting wiring shall be carried out by the Electrical Contractor to details provided by the Specialist Contractor.



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The Specialist Medical Gases Contractor shall supply duplicate wiring diagrams and instructions within four weeks of being awarded the contract.

C21.13 MEDICAL VACUUM PLANT

The Medical Vacuum Plant shall conform to NHS Health Technical Memorandum No. 02-01 (HTM 02-01). The Medical Vacuum Plant shall ensure the minimum pipeline vacuum level of 450 mmHg is maintained and the plant service connection point at the rated volumetric 'free air' flow rate. The entire system shall be 'duplexed' such that any single functional component failure will not affect the integrity of the medical vacuum supply. Triplex or quadraplex vacuum systems shall supply the specified volumetric flow with two pumps not running.

Vacuum Pumps

Vacuum pumps shall be air-cooled, oil flooded rotary vane type suitable for both continuous and frequent start/stop operation at nominal inlet vacuum levels between 475 mmHg and 600 mmHg. Aluminium composite rotor blades shall be fitted to minimise the need for maintenance and shall be supplied with a 5-year warranty. Rotors shall be driven by directly coupled TEFV electric motors with pin and bush couplings. Pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system. An integral gas ballast valve shall be fitted to filter atmospheric air, preventing oil emulsification and ensuring a high water vapour tolerance. Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame.

Bacterial Filters

The Duplex Bacterial Filter System shall incorporate high efficiency filter elements. Each filter shall be designed and sized to carry the full plant design flow capacity with a pressure drop not exceeding 33 mbar (25 mmHg). Bacterial Filter elements shall have penetration levels not exceeding 0.005% when tested by the sodium flame method in accordance with BS 3928:1969 and utilising particles in the 0.02 to 2 micron size range. Drain flasks shall be connected to each filter. Drain flasks shall be manufactured from transparent Pyrex® with a polymer coating on the inner and outer services in order to maintain a seal in the event of inadvertent breakage of the Pyrex® base layer. All drain flasks shall be suitable for sterilisation and incorporate manual isolating valves.

Control System

The Central Control Panel shall operate at extra low voltage and include BMS connections for plant fault, plant emergency and pressure fault. Cascading of vacuum pumps shall be achieved by measuring the vacuum level at the plant inlet with a pressure transducer. A mechanical back-up facility shall ensure continued operation in the event of a control system malfunction. The control system shall normally employ automatic rotation of the lead pump to maximise pump life and ensure even wear. The central control unit shall incorporate a 7-segment LED digital display of vacuum at the plant service connection.



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Receiver Assembly

Air receivers shall comply with BS EN 286-1:1998 Class 2 and be supplied with relevant test certificates. Receiver volume shall be at least 100% of the plant output in 1 minute in terms of free air aspired at normal working pressure.

CE Marking

Medical Vacuum Plant should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.

Maintenance

The Plant shall be arranged to facilitate easy and efficient inspection and maintenance.

Builder's Work

The Specialist Contactor Shall supply and fix all holding-down bolts and anti-vibration mountings for the vacuum plant installed in his sub-contact and shall supply details of all foundations and hole positions for the Building Contractor to provide. The concrete foundation block, if required, shall be of adequate mass placed on suitable resilient foundations to damp out vibrations.

Electrical Installation Work

All electrical equipment shall be supplied and installed by the Specialist Medical Gases Contractor.

The interconnecting wiring shall be carried out by the Electrical Contractor to details provided by the Specialist Contractor.

The Specialist Medical Gases Contractor shall supply duplicate wiring diagrams and instructions within four weeks of being awarded the contract.

C21.14 CENTRAL PLANT ALARM SYSTEM

Each Medical Gas Central Alarm Panel shall be capable of monitoring 5 medical gas services by means of input wiring from the source equipment, which relays deviations from the normal operating conditions. The Medical Gas Central Alarm shall fully comply with the requirements of HTM02-01, C11, BS EN 60601-1 and BS EN 60601-1-2 and BS EN 737-3.

The cover, backbox and bezel (if required) shall be polyester powder coated in a RAL9010 30% gloss finish. A single tamperproof fastener shall be used to gain access to the hinged door. The hinge shall operate through a minimum of 120° to provide adequate access.



System Operation

Each gas service shall be displayed by coloured LED's to show 'Normal' (green) and '4 Stage' alarm conditions (yellow/red). Medical vacuum shall be displayed in the 'Normal' (green) and '3 stage' alarm conditions (yellow/red) only. Failure indicators shall be displayed by flashing lights and normal indications by steady lights. Each LED block indicator shall be a plug-in component with individual long life LED's connected in parallel in 2 banks to provide duplex circuits.

An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided. Following a mute selection the audible will resound after approximately 15 minutes, or shall operate simultaneously should a further alarm condition occur. A "Mute" switch shall be provided inside the panel; for use during any maintenance resulting in prolonged pipeline or plant shutdown. This facility shall automatically reset when the gas service returns to normal.

Each Central Alarm Panel shall be capable of being programmable on-site by use of switches. The Alarm Panel shall have a 'Test' facility to prove the integrity of the internal circuits, LED's and interconnection to either a Medical Gas Central Alarm System or an Event Recording Circuit of a Building Management System.

Each alarm shall provide a green LED to indicate that electrical power is available at the panel and a red LED to indicate 'System Alarm'. In the event of an electrical power supply failure the 'System Alarm' LED shall illuminate (flashing) and the audible warning shall be delayed for 20 seconds to enable standby generator tests.

Line Contact Monitoring Circuits shall be provided to constantly monitor the integrity of the input sensors and interconnecting wiring. In the event of any fault the line contact monitoring circuits shall initiate the specific gas service failure indications, a 'System Alarm' indication and an audible warning. Further aids to fault diagnosis shall be provided by means of varying flashing rates whilst operating the 'Test' switch.

Interconnection

The Central Alarm System shall be interconnected using specific data cable on a 'radial' to considerably reduce interconnecting wiring. Signals shall be transmitted around the system in a 'multiplexed' form. The Central Alarm System must be capable of a Central Mute facility as described in HTM02-01. All interconnecting wiring between all plant compressors, vacuum pumps, manifolds etc and the central alarm panels shall be carried out by the Electrical Contractor.

Locations

The Central Alarm Panels shall be in accordance with the schedule of technical requirements and central alarms located in accordance with HTM02 and in agreement with the Hospital Trust.

CE Marking

Medical Gas Local Alarm Panels should be 'CE' marked under the Medical Devices Directive 93/42/EEC with approval from a notified body. Under this directive, the specified products are classified as Class IIb Medical Devices. Certificates should be provided.



C21.15 LOCAL AREA ALARM SYSTEMS

Each Medical Gas Area Alarm Panel shall be capable of monitoring 6 medical gas services by means of pressure sensors, which detect deviations from the normal operating limits of either pressure or medical vacuum. The Medical Gas Area Alarm shall fully comply with the requirements of HTM02, C11 BS EN 60601-1 and BS EN 60601-1-2 and BS EN 737-3.

The cover, backbox and bezel (if required) shall be polyester powder coated in a RAL9010 30% gloss finish. A single tamperproof fastener shall be used to gain access to the hinged door. The hinge shall operate through a minimum of 120° to provide adequate access.

System Operation

Each gas service shall be displayed by coloured Led's to show 'Normal' (green), 'Low' and 'High pressure' (red) conditions. Medical Vacuum Systems shall be displayed in the 'Normal' (green) and 'Low Vacuum' (red) conditions only. Failure indicators shall be displayed by flashing lights and normal indications shall be steady. Each LED block indicator shall be a plug-in component with individual long life LED's connected in parallel in 2 banks to provide duplex circuits.

An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided. Following a mute selection the audible will resound after approximately 15 minutes, or shall operate simultaneously should a further alarm condition occur. A "Mute" switch shall be provided inside the panel; for use during any maintenance resulting in prolonged pipeline or plant shutdown. This facility shall automatically reset when the gas service returns to normal.

The Alarm Panel shall have a 'Test' facility to prove the integrity of the internal circuits, LED's and audible warning. The Alarm Panel shall incorporate a volt free normally closed relay to allow for interconnection to either a Medical Gas Central Alarm system or an event recording circuit of a Building Management System.

Each alarm shall provide a green LED to indicate that electrical power is available at the panel and a red LED to indicate 'System Alarm'. In the event of an electrical power supply failure the 'System Alarm' LED shall illuminate (flashing) and the audible warning shall be delayed for 20 seconds to enable standby generator tests.

Line contact monitoring circuits shall be provided to constantly monitor the integrity of the input sensors and interconnecting wiring. In the event of any fault the line contact monitoring circuits shall initiate the specific gas service failure indication, a 'System Alarm' indication and an audible warning. Further aids to fault diagnosis shall be provided by means of varying flashing rates whilst operating the 'Test' switch.

Pressure and Vacuum Switches

Pressure and vacuum switches shall be manufactured with brass wetted parts and house a PBC with line contact monitoring resistors. Electrical connectors shall be designed for frequent disassembly. Spade connectors are not acceptable. Pressure switches shall include both high and low pressure setting in the same switch, using a single ¼" BSPF threaded pipeline connection to minimise the number of sealed joints.



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The body and housing of the pressure switch shall be manufactured from impact resistance, rigid and inherently corrosion proof materials. Elastomers and plated or coated mild steel are not acceptable materials.

Pressure switches shall connect directly to the Area Alarm Panel. It is not acceptable to install a separate connection box to convert switch signals to a data signal.

Area Alarm Panels shall be located where indicated on the drawings and in accordance with the schedule of technical requirements.

Interconnecting wiring between AVSU Line Pressure Switches and the Area Alarm Panels shall be carried out by the Electrical Contractor.

CE Marking

Medical Gas Local Alarm Panels should be 'CE' marked under the Medical Devices Directive 93/94/EEC with approval from a notified body. Under this directive, the specific products are classified as Class IIb Medical Devices. Certificates should be provided.

C21.16 VALIDATION AND VERIFICATION

The Specialist Contractor shall allow for and comply with the requirements for commissioning and testing the complete installation in accordance with Health Technical Memorandum 02 and the Department of Health National Engineering Specification C11.

The Specialist Contractor shall carry out all test procedures required for either new installation, additions to existing installations and satisfy himself that the installation conforms to the specification prior to carrying out:-

- a) Tests and checks on pipeline carcass.
- b) Tests and commissioning of the complete pipeline system for safety performance and particulate contamination using test gas.
- c) Filling of the systems with specific gases for the purpose of identity and quality tests of the specific gas prior to use for patient care.

In order to carry out these tests the Specialist Contractor shall provide the test equipment needed and arrange for either:-

- a) Contractors representative
- b) MGPs authorised person
- c) Contract Supervising Officer
- d) MGP Quality Controller

To witness their various test responsibilities in accordance with HTM02, Section 15, Table 27.

The Specialist Contractor shall carry out test on the AGSS Disposal system to comply with the requirements of BS 6834:1987 and the performance test figures outlined in HTM 02 Section 15.171 and witnessed by the nominated MGPs Authorise Person.



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The Specialist Contractor shall ensure that all test certification, as fitted drawings and manuals are correct and certificates are signed by the Authorised Person (MGPs) and the Contract Supervising Officer. These shall be in accordance with the requirements of HTM 02 Appendix A – testing, commissioning and filling for use: forms to be completed during testing and commissioning of MGP systems Forms BO to B16 and appendix:-

- B – Pressure Variation with Temperature
- C – Pressure Drop Test Devices
- D – Membrain Filter Test Devices
- E – Equipment For Containment Tests
- F – Equipment For Gas Identification



PART C - SECTION 25 TESTING AND COMMISSIONING

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PART C - SECTION 25

TESTING AND COMMISSIONING

C25.1 GENERAL

Seven days notice of works tests shall be given to enable the test to be witnessed.

After erection, the installation or sections of the installation or plant items shall be tested. Where necessary, the installation shall be tested in sections.

Three copies of all test certificates shall be forwarded on completion of all testing and commissioning.

Storage cylinders, indirect cylinders, calorifiers, radiators, automatic control valves, heater batteries and the like shall not be subjected to an hydraulic pressure greater than the manufacturer's test pressure and if necessary such special items shall be disconnected from the pipework system when this is being tested. When the pipework has been satisfactorily tested, the system, including all components, shall be re-tested if necessary at a maximum test pressure suitable for all components.

All testing and commissioning shall be carried out as recommended by standard testing procedures of the C.I.B.S.E. Guide to Current Practice and Commissioning Codes Series A,B,C,R and W, British Standard Codes of Practice, the Association of Heating and Ventilating and Domestic Engineering Employers, BSRIA, and/or as otherwise specified.

If due to constraints within the system the standard testing procedures cannot be undertaken, the revised procedure shall be agreed with the Services Engineer.

All instruments and equipment required to satisfactorily complete the Commissioning Tests shall be provided as part of this section of the works. The accuracy of all test instruments shall be demonstrated, and all instruments used during the testing and commissioning procedures shall be re-calibrated before use. Evidence of this re-calibration shall be presented to the Services Engineer, prior to use. A list of all the proposed testing equipment to be used during the works shall be forwarded to the Engineer prior to commencement of any testing works.

Before proceeding with a test all steam and water installations shall be thoroughly flushed out, until it runs free of all contaminants.

Balancing of all water systems shall be carried out to produce a 10% differential (based on design flow rates) between highest and lowest measurement values.

The balancing and regulation of the Building Engineering Services shall be undertaken by specialists in this work equal to :

End Systems Ltd., Redwater House, Brunswick Street, Leigh, Lancashire, WN7 2PL.
Tel: 01942 673229, Fax: 01942 260155.

Sutton Services International Ltd., Unit 8 Mercury, Orion Way, Orion Business Park, North Shields, Tyne & Wear, NE29 7SN. Tel: 0191 296 2999, Fax: 0191 296 5296,
Email: newcastle@sutton-services.co.uk



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Cardiff Commissioning Ltd., Laytonia House, Laytonia Avenue, Cardiff, CF14 3BQ. Tel: 029 20521111.

Phillips Commissioning Services Ltd., 26 Chesham Gardens, Chapel House, Newcastle-upon-Tyne, NE5 1EQ. Tel. 07768 893 452.

Where Commissioning Tests are required to be carried out on specialist equipment and installations, the attendance of the Specialist Manufacturer/Installer, together with any specialist test equipment, shall be provided as part of this section of the works.

All commissioning personnel shall be properly trained and competent in the use of the instruments they are using.

C25.2 STEAM AND CONDENSATE INSTALLATION

Pressure Test (before insulation and painting)

The whole of the system shall be filled with water and tested to a pressure of twice the working pressure of the boiler plant.

The test pressure shall be maintained for as long as necessary to inspect the whole of the pipework involved. After dealing with all weak joints and defective fittings and pipes disclosed by the initial application tests, the tests shall be repeated after all defects have been repaired and the test pressure maintained for as long as necessary to ensure that all sections of the installation have been maintained under tests for a minimum period of thirty minutes.

When the test has been completed the system shall be emptied down and allowed to flush itself by removing sections from the lowest points of the installation.

Where pressure tests involved may cause undue strain or damage to the expansion bellows installed, dummy pieces shall be provided in the pipe lines during the tests, which shall be equal in length to the expansion bellow plus an allowance of one third the expansion rate for cold draw.

Where a test pressure of twice the normal working pressure exceeds that allowed on any component in the system, these items shall be removed or isolated before the pipework is tested. The whole system shall then be re-tested to a maximum pressure acceptable to all components.

C25.3 LOW, MEDIUM & HIGH PRESSURE HOT WATER HEATING INSTALLATION

Pressure Test (before insulation and painting)

The whole of the system shall be filled with water and tested to twice the normal working pressure.

Additional hydraulic tests shall be carried out on heating coils as follows:-

Ceiling coils shall be tested to 10.5 bar.

Embedded floor coils shall be tested to 28.0 bar.



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The test pressure shall be maintained for 30 minutes after dealing with all weak joints, defective fittings and pipes disclosed by the initial application of the test. The test shall be repeated after any defect has been repaired.

When this test has been completed the system shall be emptied down and allowed to flush itself by removing sections from the lowest points of the installation.

Where the pressure tests involved may cause undue strain or damage to the expansion bellows installed, dummy pieces shall be provided in the pipelines during the tests, which shall be equal in length to the expansion bellows plus an allowance of one third the expansion rate for cold draw.

Where a test pressure of twice the normal working pressure exceeds that allowed on any component in the system, these items shall be removed or isolated before the pipework is tested. The whole system shall then be re-tested to a maximum pressure acceptable to all components.

Thermal Test (after insulation and painting)

A series of approved tests shall be performed on the heating installation before handover and during the first full heating season, or after handover at a time agreed with the Services Engineer.

Records in triplicate shall be made of these tests which shall include temperature of normal operation.

C25.4 HOT WATER SUPPLY INSTALLATION

Pressure Test (before insulation and painting)

The whole of the system shall be filled with water and tested as detailed for the Hot Water Heating Installations.

Where a test pressure of twice the normal working pressure exceeds that allowed on any component in the system, these items shall be removed or isolated before the pipework is tested. The whole system shall then be re-tested to a maximum pressure acceptable to all components.

Thermal Test (after insulation and painting)

A series of tests shall be performed on the hot water supply installation to Code of Practice C.P.342. Records shall include normal temperature, flow and pressure head available at fittings and equipment served.

C25.5 COLD WATER INSTALLATION

The installation shall be pressure tested as detailed for the Hot Water Heating Installations.

C25.6 FIRE PROTECTION

All sprinkler, hose reel, dry riser, wet riser, foam pipework installations and the like shall be pressure tested as detailed for the Hot Water Heating Installations.



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Dry riser installations shall be further tested by the local Fire Brigade.

C25.7 GAS INSTALLATION

The installation shall be tested in accordance with BS 6400 and BS 6891.

The ends of the mains shall be capped with the exception of the one which will be fitted with a tee-piece carrying a cock on one outlet and a pressure gauge on the other. Air shall then be pumped into the pipe until the pressure of 300mm water gauge or twice the maximum working pressure, whichever is the greater, is registered on the pressure gauge. The cocks shall be shut and after allowing five minutes for adjustment of temperature, the pressure shall remain constant for a further period of not less than thirty minutes.

Sections of the installation which will be embedded in the structure or otherwise concealed shall, in addition, be tested as they are laid and before the pipes are concealed.

C25.8 CHILLED WATER AND REFRIGERATION INSTALLATION

Pressure Test (before insulation and painting)

All chilled/warm water pipework shall be filled with water and tested to twice the normal working pressure or 7.0 bar, whichever is the greater. These pressures shall be maintained for as long as is necessary to inspect the whole of the pipework involved.

The whole of the system shall then be filled with water and tested to twice the normal working pressure. The test pressure shall be maintained for thirty minutes after dealing with all weak joints, defective fittings and pipes disclosed by the initial application of the test, and cleaning the water filters.

When this test has been completed, the system shall be emptied down and allowed to flush itself by removing sections from the lowest points of the installation.

Where a test pressure of twice the normal working pressure exceeds that allowed on any component in the system, these items shall be removed or isolated before the pipework is tested. The whole system shall then be re-tested to a maximum pressure acceptable to all components.

Thermal Test (after insulation and painting)

A series of approved tests shall be performed on the installations (i) during the Summer period (ii) during the heating season. Records shall be made of these tests together with their associated ventilation and air conditioning plant records.

Refrigeration Equipment

All refrigeration equipment shall be tested in accordance with BS 4434, BS EN 12900, BS 7120 and BS 1586.

C25.9 COMPRESSED AIR INSTALLATIONS

The compressed air installation shall be filled with air and tested to 10.0 bar or twice the working pressure whichever is the greater. This pressure shall be maintained for as long as is necessary to inspect the whole of the pipework involved.



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The test pressure shall be maintained for thirty minutes after dealing with all weak joints, defective fittings and pipes disclosed by the initial application of the test. The test shall be repeated after any defect has been repaired.

No part of the piped system shall be pressure tested unless the part concerned has been physically separated from any part in use or liable to be used. The closure of isolating valves alone is insufficient.

Where a test pressure of twice the normal working pressure exceeds that allowed on any component in the system, these items shall be removed or isolated before the pipework is tested. The whole system shall then be re-tested to a maximum pressure acceptable to all components.

C25.10 MEDICAL VACUUM INSTALLATION

The medical vacuum installation shall be purged, tested and commissioned in accordance with HTM 02.

No part of the piped system shall be pressure tested unless the part concerned has been physically separated from any part in use or liable to be used. The closure of isolating valves alone is insufficient. The physical isolation of parts of existing systems under test is essential until the final check for correctness of gas outlets.

C25.11 MEDICAL GASES INSTALLATION

The medical gases installation shall be purged, tested and commissioned in accordance with HTM 02.

No part of the piped system shall be pressure tested unless the part concerned has been physically separated from any part in use or liable to be used. The closure of isolating valves alone is insufficient. The physical isolation of parts of existing systems under test is essential until the final check for correctness of gas outlets.

C25.12 VENTILATION INSTALLATION

(1) General Ventilation Equipment

All specialist equipment (fans, filters, washers, heaters, coolers and the like) shall be tested to the relevant Standard Testing Procedure.

Prior to testing of the ductwork all dust and other materials shall be removed from the ductwork and grilles and specialist equipment removed from the ducting. If necessary, cleanliness shall be demonstrated by dismantling sections of ductwork.

Prior to testing, all equipment e.g., filters, air heaters and coolers, washers, specialist equipment, grilles and the like shall be thoroughly cleaned.



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A series of approved tests shall be performed on the Air Conditioning, Ventilation Systems during the Winter and Summer seasons. Records shall be made of these tests which shall include the following:-

- a) All fan speeds and duties (inclusive of inverter operation, where fitted).
- b) All dampers and valves shall be adjusted to obtain the design air flow rates.
- c) All water valves shall be adjusted to give proper water circulation.
- d) All pump speeds and duties.
- e) Temperature and humidity readings shall be taken in individual rooms chosen by the Services Engineer.
- f) The water chiller unit shall be tested and commissioned by the manufacturers after installation.
- g) Sound levels in selected areas.
- h) Actual air volumes obtained compared with design volumes.

(2) Low, Medium & High Pressure Air Distribution Ductwork

All air distribution equipment shall be tested as determined by the Services Engineer in accordance with BS 5720.

All air ductwork shall be pressure tested strictly in accordance with Appendix 'A', DW.144 for leaks before the ductwork is insulated and before any terminal units are finally connected to the ductwork system. A leakage sheet is required to be completed. A specimen air leakage sheet can be found in Appendix A of DW.144 for guidance purposes.

(3) Kitchen Ventilation Systems

The testing of all kitchen installation systems shall comply with the requirements of the Standard for Kitchen Ventilation Systems DW/171 published by the Heating and Ventilating Contractors Association.

C25.13 THERMAL INSULATION

Preformed thermal insulating material shall be subjected to a thickness test as described in BS 5422.

The thickness of the insulating material for plastic composition, flexible and dry filled thermal insulation material shall be determined after installation and in the case of plastic composition materials when finally dry.

If the tests for thickness carried out in accordance with the procedure outlined in BS 5422 show that the insulating materials has been applied to a thickness less than required, then the additional thickness required shall be installed without extra cost.



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C25.14 ELECTRICAL EQUIPMENT

All electrical equipment and internal wiring or wiring forming an integral part of mechanical equipment or of the Contract shall be tested in accordance with BS 7671.

Three copies of inspection certificates as prescribed by BS 7671 shall be submitted for approval. The tests required are as follows:-

Insulation	(Regulation 713-04)
Polarity	(Regulation 713-09)
Continuity	(Regulation 713-02 and 713-03)
Earth Electrode Resistance	(Regulation 713-11)
Protection	(Regulation 713-06 and 713-07)
Earth Fault Loop Impedance	(Regulation 713-10)
Operation of Protective Devices	(Regulation 713-12)

C25.15 PLANT AND EQUIPMENT

The installations shall be maintained and run for as long as required to ensure that all plant, equipment, control, and the like are working correctly. This period shall commence after the completion of all the adjustments. The correct operation of all plant, services, controls and instruments and each item of equipment shall be proved by demonstration to the Services Engineer, prior to the works being handed over to the Client.

Should the completion of the witnessed demonstrations be prevented during the period agreed for witnesses attendance and have to be postponed to a later date, by reason of the Contractor/Sub-Contractor failing to ensure that all of the installation has been prepared for functioning in a correct, safe and proper manner, and in accordance with the specified requirements, then the Contract/Sub-Contract sum may be reduced by an amount equal to the expenses incurred by the witnesses having to return to site at a later date for resumption of the testing.

Further attendance shall be provided for supervising and instructing the Client's Engineer on the correct operation and maintenance procedure of all plant, equipment, controls and the like.

C25.16 CONFIRMATION OF SETPOINTS

Before commissioning is commenced, the Services Engineer shall be requested to confirm all setpoints.

C25.17 MISCELLANEOUS PIPEWORK MATERIALS

Other materials such as those identified below and agreed for use for the above noted heating, chilled water and domestic water services, shall be tested in accordance with the testing procedures previously detailed for those services. The Contractor shall ensure that the range of pipework selected adequately suits the relevant service and the necessary pressures to be obtained :

MDPE
Polypropylene
PVC
ABS



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PART D - SECTION 1 DRAWINGS

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PART D - SECTION 1

DRAWINGS

D1.1 TENDER DRAWINGS

The following drawings shall constitute part of the tender documents and shall be called the Tender Drawings. These drawings when read in conjunction with the Specification provide information for tendering :-

LIST OF DRAWINGS TO BE INSERTED

00(53)001 – Ground Floor Domestic Services Layout
01(53)002 – First Floor Domestic Services Layout
02(53)003 – Second Floor Domestic Services Layout
00(55)001 – Ground Floor Air Conditioning Layout
01(55)002 – First Floor Air Conditioning Layout
02(55)003 – Second Floor Air Conditioning Layout
00(56)001 – Ground Floor Heating Layout
01(56)002 – First Floor Heating Layout
02(56)003 – Second Floor Heating Layout
00(57)001 – Ground Floor Ventilation Layout
01(57)002 – First Floor Ventilation Layout
02(57)003 – Second Floor Ventilation Layout
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D1.2 INSTALLATION DRAWINGS

Installation drawings shall be produced which, in the opinion of the Contract Administrator/Services Engineer, are necessary for the proper execution of the works and the co-ordination of all trades.

The following constitute the main requirements but do not reduce the Supervising Officer/Services Engineer's right to call for additional information if this is shown to be necessary.

- (a) Layout of all plant rooms.
- (b) Comprehensive wiring diagrams of all electrical and control equipment that forms part of this contract.
- (c) Positions of all thermostats, sensors, controllers etc.
- (d) Special pipe guides and brackets.
- (e) Builders work drawings showing all builders work detail including all holes through structure, chases, ducts etc. and all plant bases.
- (f) Ductwork drawings.
- (g) Dimensional pipework location drawings and details.
- (h) Manufacturer's working drawings.
- (i) Manufacturer's working drawings if any alternative equipment being suggested.

The production of the installation drawings must suit the contract programme.



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The drawings shall be produced at a time to allow a period of four weeks for initial consideration by the Design Team and a further two weeks for formal issue of the drawings. Work shall not be commenced until drawings have been formally issued.

The installation drawings shall be fully co-ordinated with all other services including the drainage system, structural and building details.

The Contractor/Sub-Contractor shall include in his drawing production programme a period of four weeks for initial consideration by the Design Team and a further two weeks for formal issue of drawings. Work should not be commenced until the drawings have been formally issued under the Contract.

D1.3 RECORD DRAWINGS

Record Drawings shall be provided as detailed in Clause 'Record Drawings' Part B.



PART D - SECTION 2

SPARES, TOOLS & ACCESSORIES

D2.1 GENERAL

Spares, tools and accessories shall be provided as part of this Section of the Works, and as necessary to enable the installations forming a part of this Section of the Works to be fully maintained during the defects liability period and thereafter in accordance with the manufacturers recommendations. In addition the spares as listed below, and included elsewhere in this specification, shall be provided immediately prior to, or at handover of the works to the Client.

Receipts signed by the Client's representative shall be obtained for all spares handed over, and these shall be forwarded to the Services Engineer as proof of delivery to the Client.

NB Not for inclusion in specifications. Basic spares, tools and accessories include items such as fan belts, pump belts, filters, lamps, cleaning tools, oils, grease, etc.

- 1No. DHW Secondary Circulation Pump
- 1No. External Temperature Sensor (Supplied by Hamworthy)
- 1No. Immersion temperature sensor
- 2No. Temperature Gauges (As installed)
- 2No. Pressure Gauges (As installed)
- 1No. 3-Port Mixing Valve (As installed)
- 1No. Valve Actuator (As installed)



PART D - SECTION 3 SCHEDULES OF TECHNICAL REQUIREMENTS

CONTENTS

D3.1 Boiler Plant

Hamworthy Fleet F150W wall mounted condensing boiler

Dimensions 970 x 540 x 570mm

Weight empty 130kg

Flow and Return connections 32mm

Flue Connection 100mm

Air supply connection 150mm

Gas connection 25mm BSP

Power consumption 230Volts

Fuse protection 6amps.

Heating performance 26.9-135.4kW

Nominal Heat output 80/60 °C 26.9-135.4kW

A cost for the above equipment and accessories (not shown) can be obtained from:

Julie Moore

Hamworthy Heating Ltd

Fleets Corner
Poole
Dorset
BH17 0HH

Telephone 01384 372705
 07917 168710

Julie.moore@hamworthy-heating.com

Or equal and approved.



PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.2 Pressurisation and Expansion Unit

A pressurisation unit shall be supplied and installed generally as indicated on the tender drawings. The pressurisation unit must be fully compliant; any aspect of this clause that cannot be complied with must be identified when submitting the pressurisation unit tender. The pressurisation unit manufacturer shall be fully responsible for correcting any subsequent non-compliant aspect of the pressurisation unit.

The unit shall be fully packaged and pre-wired requiring only a 3- phase electrical supply to be fully operational.

The unit shall comprise a suitably sized expansion vessel for the heating system together with duty and standby pumps (arranged for auto-changeover and duty sharing), accumulator feed tank with local water authority approved ball valve, and control panel, all mounted on a common base frame.

The integral controls shall include pressure reducing valves, control pressure switches, and high and low level pressure cut out switches to automatically operate the unit to provide constant minimum system pressure whilst maintaining a relatively constant system water content compensating for any minor leaks in the system.

Visual indication shall be provided on the units control panel for panel live, pumps run and trip conditions and high and low pressure fault conditions for the system, together with facility for remote indication of high and low pressure alarms for the system and pump trip conditions. In addition a low pressure pre-alarm warning condition for the system set between the low pressure control and low pressure fault conditions shall be arranged to illuminate a lamp on the control panel.

The vessel provided as part of the unit shall be selected such that the heating systems volume of expansion from ambient temperature to operating temperatures can be accommodated within the vessel and within the specified pressures without the need for water discharge or make-up from the system. A replaceable diaphragm membrane shall be provided between the water and the air within the expansion vessel.

The pressurisation unit shall be selected to suit the following system criteria and shall be installed and commissioned fully in accordance with the manufacturer's recommendations.

Application	LTHW Heating
Operating Temperatures	80°C Flow, 60°C Return
Static Height of System	5.0 metres
Maximum Allowable Working Pressure (Gauge)	3.2 bar
System Water Content (approx)	1,944 litres (to be confirmed).

Pressurisation units shall be provided capable of providing a constant minimum heating unit/system pressure whilst maintaining a relatively constant system water content compensating for any minor leaks. Where specified, each unit shall be complete with standby pump with duty sharing and automatic changeover facilities.



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Each unit shall be fully automatic incorporating high/low pressure cut out switches, visual indication, control pressure switches, accumulator feed tank and ball valve and suitably sized expansion vessels.

It should be noted that 3 tiers of pressure control shall be provided on both the high and low pressure conditions. The three tiers shall be:- 'control', 'remote warning' and 'trip'. Only the trip condition shall shut down associated plant, in accordance with the Automatic Controls system.

Each unit shall be positioned in the system as indicated on the drawings and shall incorporate an accumulator vessel and pressure reducing valve to avoid erratic pump operation.

Each pressurisation cylinder provided as part of a pressurisation unit shall be selected such that each unit/system volume expansion from ambient temperatures to operating temperatures can be accommodated within the vessel, and within the specified pressures, without the need for water discharge, or make up for the system.

A replaceable diaphragm membrane shall be provided between the water and the air within the expansion vessel.

Under no circumstances shall any obstruction i.e., isolating valve or NRV be placed in the pipework between each pressurisation unit expansion cylinder and the heating unit/system to which it is connected.

The pressurisation unit shall be fully packaged and pre-wired requiring only an electrical supply and control alarm circuits to be fully operational. The integral controls shall incorporate facilities for indication of high pressure and low pressure alarm, pump run and trip both on the control panel forming part of the unit and for remote indication.

The cold water connection to each unit shall incorporate a type 'A' air gap.

The Sub-Contractor may offer an alternative manufacturer to the Engineer for consideration provided they comply with the specification and can be delivered to meet the Construction Programme.

All equipment shall be installed, tested and commissioned as per the manufacturer's recommendations.

Important note: The whole of the LTHW distribution system shall be pressurised by means of a dual pump pressurisation unit complete with a suitably sized pressure vessel and break tank. Careful consideration needs to be given to the selection of pressurisation and expansion equipment, to limit the pressure within the heating system.

Contact Richard Waters

Mikrofill

T - 08452 60 60 20

F - 08452 60 60 21

M - 078884 23 16 18

www - www.mikrofill.com

Mikrofill Systems Ltd

West Court
Merse road
North Moons Moat
Redditch



B98 9HL

Or equal and approved.

PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.3 Heating Circulation Pumps

Pump 1 Heating circulation pump (VT)

Grundfos Magna cast iron twin head pump

Power 1 phase 230V

Pump 2 Heating Circulation pump (CT)

Grundfos Magna cast iron twin head pump

Power 1 phase 230V

Pump 3 DHW return pump

Grundfos Magna bronze single pump

Power 1 phase 230V

A cost for the above equipment can be obtained from:

Mr Steve Hooper

Birmingham Pump Supplies Ltd

Telephone 0121 503 3000

Or equal and approved.



PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.4 Domestic Hot Water (DHW) Generator

Hamworthy Dorchester

DR-FC Evo 80

Weight empty 480kg

max working pressure 5.5 bar

DHW flow and return connection 40mm dia

Cold Water Inlet 32mm dia

Julie Moore

Hamworthy Heating Ltd

Fleets Corner

Poole

Dorset

BH17 0HH

Telephone 01384 372705
 07917 168710

Julie.moore@hamworthy-heating.com

Or equal and approved.

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PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.6 VRV Heat Recovery Air Conditioning Systems

3-Pipe Heat recovery VRV air conditioning system as manufactured by Daikin Ltd.

.

A proposal for the above equipment and accessories (not shown) can be obtained from:

Mr Nick Gould

Daikin Air Conditioning UK Ltd.
Unit 8 Holly Park
Spitfire Road
Birmingham
B24 9BP

0845 641 9370

Or equal and approved.



PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.7 Air Handling Units

MAX

25mm Specification MAX A & MAX C

1.1. General

A. Provide an air handling unit to meet the performance and configuration as indicated in the schedule and detail drawings. The air handling unit shall be tested to BS848 Part 1 and shall be of the MAX A & MAX C type as manufactured by VES Andover Ltd a company accredited with BS EN ISO 9001:2008.

B. The unit shall conform to the schedule regarding case construction, component layout & finish. The detail drawings shall be supplied for approval where indicated in the schedule.

1.2. Unit Construction

A. The unit shall be provided pre-assembled comprising of a rigidly constructed 25mm tubular aluminium case & double skinned galvanised sheet steel panels.

B. The unit shall be constructed to BS EN1886 standard & fully BSRIA tested for compliance to deflection rating class D1, leakage class L2 & thermal transmittance classes of T5 & TB5. Testing certificates shall be available on request.

C. The unit shall be supplied in multiple sections for transporting & site installation as indicated in the schedule & detail drawings. The unit shall be pre-drilled & gusseted for sectional re-assembly on-site by others as indicated in the detail drawings and O&M documentation.

D. The unit shall be available in a partially disassembled 'flat pack' form for ease of installation with awkward on-site access. Flat pack units shall be reassembled on-site by VES technical personnel as indicated in the schedule.

E. The unit shall be available in plantroom or weatherproof construction as indicated in the schedule and detail drawings. Weatherproof units shall have an extended pitched lid supplied fitted as standard.

F. The unit shall have component arrangement as indicated in the schedule & detail drawings.

G. The unit shall have plain rectangular duct spigots as standard. Flanges shall be fitted as indicated in the schedule & detail drawings.

H. The unit casework shall incorporate high quality leak resistant EPDM memory retaining clip-on gaskets on service & access panels

I. The unit casework shall be available with optional double-glazed inspection portholes supplied fitted as indicated in the schedule & detail drawings.



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J. The case panels shall be filled with inert mineral wool infill as standard. The panels shall be available with optional heavyweight plasterboard infill as indicated in the schedule & detail drawings.

K. The case tubes shall be unfilled as standard. The tubes shall be available with optional heavy weight lead bead infill as indicated in the schedule & detail drawings.

L. Units shall have access as indicated in the schedule & detail drawings. Where unit access details are not supplied, the unit shall be handed LHS looking in direction of supply airflow as standard, to be confirmed by drawing approval.

M. Plantroom unit casework & spigots shall be supplied naturally finished in high quality galvanised steel as standard. Optional powdercoated colour as indicated in the schedule
VES reserve the right to amend product specifications and details without notice.

ISO 9001:2008

PRODUCT SPECIFICATION

1.2. Unit Construction

N. Weatherproof units shall be supplied powdercoated signal grey RAL7004 as standard. Alternative colour according to schedule.

O. The casework shall be available with internal epoxy powder coating suitable for coastal or corrosive environments as indicated in the schedule & detail drawings.

P. The unit shall be designed to be secured to a suitable base or support frame, ensuring the use of correct fixings for the application and taking into account individual section & overall unit weight as indicated in the schedule and detail drawings

1.3. Unit Base Frame

A. The unit shall be supplied as standard on a galvanised sheet steel channel base. The unit shall be available with optional drop rod mounting feet as indicated in the schedule & detail drawing.

B. The frame shall be 100mm high as standard, height as indicated in the schedule & detail drawings.

C. The frame shall be available with optional lifting slots, suitable for use with strops or fork lifts. The frame with slots shall be a minimum of 125mm high.

D. The frame shall be finished to match the unit casework.

E. The frame shall be available with optional drop rod mounting holes.

1.4. Inlet/Outlet Cowls

A. Weatherproof unit casework shall be supplied with fresh air inlet & exhaust discharge cowls/ louvers where indicated in the schedule & detail drawing.

B. Cowls shall be single skinned galvanised sheet steel, finished to match the unit casework.

C. Cowls shall be available with optional flame retardant acoustic internal lining to ensure maximum thermal insulation and reduced noise transmission.



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Contact Mathew Cherrington

VES Andover Ltd.
Eagle Close
Chandler's Ford Industrial Estate
Eastleigh
Hampshire
SO53 4NF

07827 323896

Or equal and approved.



PART D - SECTION 3

SCHEDULES OF TECHNICAL REQUIREMENTS

D3.8 Controls

BEMS System in accordance with section C1.2.14 of this specification

A cost for the above equipment and accessories (not shown) can be obtained from:

Mr Mike Everell

Robell Control Systems

0121 333 4306

mike@robell.co.uk

Or equal and approved.