Project Castle
Brethertons Offices

Electrical & Mechanical Services

Performance Design Brief
For Contractor Design

For

Cherwell District Council

Date: 27th September 2021
Ref 11633MES1
Issue: T1

Part A – Preface to Specification

Document Contents

Note – Amendments from previous issues shown in italics. Omissions are lined through.

Approved:  Date: 27th September 2021

(Director)

Part A – Preface to Specification

Contents

Part A – Preface to Specification

1.0 Description of The Project

1.1 The existing Castle Quay Shopping Centre store for Marks & Spencer has been vacated. A section to the rear of the store on two levels is to be configured to provide new office accommodation to the Client. The office will be independent with new services from the local suppliers off the network infrastructure, with the sprinkler connection being extended from the centre system via the landlord corridor to the side of the site and the fire alarm being interfaced to the centre system. The first floor area will be completely open soffit with exposed services, and the ground floor having a new MF ceiling with flush services to the area.

2.0 Reference to Specification Parts

2.1 This specification comprises:-

Part A Preface to Specification

Part B Design Criteria

Part C Electrical Services

Part D Mechanical Services

Part E Room Data Sheets

Part F Schedules

Part G Return Tender Documents

Appendices

Appendix A Standard Electrical Clauses

Appendix B Standard Mechanical Clauses

2.2 Bennett Williams Workmanship clauses should be adhered to in preparation of the tender price and for installation guidance.

2.3 Should any clauses within this specification conflict the Contractor shall be deemed to have included for compliance with the most onerous condition.

3.0 Employer and Professional Team

Employer

Cherwell District Council
Bodicote House
Bodicote
Banbury
OX15 4AA

Part A – Preface to Specification

Project Manager	NCS Property Consultants The Exchange 19 Newhall Street Birmingham B3 3PJ Tel No: 0121 259 0370
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Quantity Surveyor	NCS Property Consultants The Exchange 19 Newhall Street Birmingham B3 3PJ Tel No: 0121 259 0370
Principal Designer	GBS St Thomas House 6 Becket Street Oxford OX1 1PP Tel No 01865 305130
Building Services Engineers	Bennett Williams 106 Dixons Green Road Dudley West Midlands DY2 7DJ Tel No: 01384 238222 Email: office@bennettwilliams.co.uk

4.0 Definition of Terms

4.1 Within this specification the following terms have the following definitions:-

"shall"	is mandatory
"will"	is informative

"should"	is advisory
"provide"	means supply, fix and install
"Contractor"	shall mean the Tendering Contractor

5.0 Information Provided to Tenderers

5.1 This document sets out the principal requirements of the installation but does not relieve the Contractor of his responsibilities for any part of the installation to achieve the necessary performance.

5.2 The drawings issued with this specification are supplied as indicative only. In any discrepancy between the drawing and specification then the specification takes precedence. Drawings shall be read in conjunction with the Architects and other Consultant's drawings.

5.3 Any indicative drawings and layouts issued with this document have been prepared on the basis of the Architects design drawings. They indicate scope of work, materials required, methods and standards for the installation etc.

5.4 The Consultant will review the Contractors design proposals and make any observation and comment as felt necessary. Such observation or silence by the Consultant shall not in any way effect the contractual obligations of the Contractor or warranties given.

5.5 Data sheets where provided with this specification are intended to indicate the end users requirement over and above the recommended or Building Regulation requirement for each room. Where no specific requirements are shown the Contractor shall install the services specification to the Architectural drawings, Building Regulation requirements and CIBSE recommendations.

6.0 General Requirements of Tendering Contractor

6.1 All installations specified in this document shall be designed, supplied, delivered, off-loaded, installed, tested/commissioned and left in full working order.

6.2 The Contractor shall be deemed to have examined the site, the conditions of main contract, the specification, schedules, drawings and plans and included for all relevant costs within his tender. Claims for lack of knowledge in this respect shall not be entertained.

6.3 The design and installation of the various services installations shall comply with accepted good practice and the following standards and recommendations:-

- The current edition of BS7671 – Wiring Regulations.
- Electricity at Work Regulations.
- Relevant Codes of Practice, British Standards and European Harmonisation Documentation.
- Construction Design and Management Regulations 2015.
- Local Authority Bye Laws and Building Regulations.
- CIBSE Guides & Technical Memoranda.
- All Statutory Regulations and EC Directives.

Part A – Preface to Specification

- All Current Health and Safety Legislation.
- Fire Precaution Act 1971.
- Fire Precaution (Work Place) Regulations 1997 as amended.
- F-Gas and Ozone Regulations.
- Waste Electrical and Electronic Equipment Regulations 2013.
- Contractors Trade Association Recommendations.
- Equipment manufacturers installation guidance and recommendations.
- Supply authority guidance and recommendations.
- Disability and Equality Act 2010.
- COSHH Regulations.
- Non-Domestic Building Services Compliance Guide.

6.4 Allowance should be made for all necessary negotiations with relevant Local Authorities and Supply Companies.

6.5 The following services installations shall be provided:-

- Negotiations with Service utilities for the integration of Electricity, Gas, Water and Telephone supplies.
- Negotiations and implementation of the requirements of Building Control and the Fire Prevention Officer.
- Electrical Services including:-

    i) LV Mains incomer
    ii) LV Distribution and Sub-Mains
    iii) Distribution boards and Sub-circuit wiring
    iv) Earthing
    v) Main Lighting
    vi) Emergency Lighting
    vii) External Lighting
    viii) Small Power
    ix) Mechanical Wiring
    x) Fire Alarm
    xi) Intruder Alarm, Security and Access Control
    xii) Telephones Cabling & Containment
    xiii) Data Cabling & Containment
    xiv) Lightning Surge Protection

- Mechanical Services including:

    i) Water Incoming Service
    ii) Heating Systems
    iii) Controls
    iv) Domestic Water Services
    v) Mechanical Ventilation
    vi) Comfort Heating/Cooling
    vii) Sprinklers
    viii) Dry Risers

Part A – Preface to Specification

7.0 Drawings

7.1 The Contractor shall supply with his initial proposals specifications; 1:100 scale drawings and schedules of manufacturers equipment for the proposed installation in sufficient detail to allow assessment of the tender. During the review period it may be necessary for the Engineer to request further detail of the tender and associated documents submitted.

8.0 Contractor Design

8.1 The Contractor shall provide in good time and not less than 20 working days prior to the commencement of each stage of the works on site copies of all design drawings and supporting calculations to the Employer's Agent for comment. The drawings and calculations shall be sufficiently detailed and complete to allow the design to be checked. A period of 10 working days shall be allowed for the return of the drawings and calculations with comments.

8.2 The installation shall be complete in every respect including all ancillaries and all works, whether specifically mentioned in this documentation or not, necessary for the systems to be tested, balanced, commissioned and perform correctly as intended in the design intent. Where trade names are used, the intention is to indicate a standard. Equipment of equivalent manufacture and performance may be included, provided such equipment is submitted in accordance with the specified procedure.

9.0 Consultation

9.1 The document shall not be varied in any way unless agreed in writing. Adequate time for consultation between all parties is required before an item of work is undertaken, adequate time must be allowed for comments to be given in writing and identified in the project programme.

9.2 Comments made on drawings or proposals signify only general comment in principle to the arrangement shown and shall not relieve the Contractor of his responsibilities for discrepancies, errors or omissions, 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.

10.0 Schedules of Quantities and Rates

10.1 Except where the services documents include a priced Bill of Quantities, a copy of the schedule of quantities and rates upon which the cost has been based shall be provided. The schedules shall be fully priced and totalled to the original cost. It shall be used for the pricing of future variations.

10.2 Where discrepancies arise the quantities and/or rates shall be corrected as necessary but the total sum shall not be amended as a result.

11.0 Sub-Letting

11.1 The Contractor shall state at the time of the tender the names of all firms to whom he proposes to sub-let portions of the work.

11.2 Approval of the sub-letting shall not relieve the Contractor of any of his obligations under his

Contract. The Contractor shall be responsible for the programming and execution of all the work sub-let.

12.0 Co-ordination

12.1 The Contractor shall co-ordinate their installation with all other Contractors and the building fabric.

12.2 The co-ordination exercise shall include:-

a) Attendance at co-ordination meetings.

b) Issue of drawings as later described to the design team for comment, via the Employer's Agent. Amending the working drawings to take into account all valid comments.

13.0 Installation Drawings

13.1 The Contractor shall provide installation drawings and working drawings prior to the commencement of works. The cost of such provision shall be borne by the Contractor.

13.2 Working drawings shall contain all necessary information for the Engineer to assess the technical and practical suitability of the Contractors proposals. Where necessary the working drawings shall be supported by schedules and proof of co-ordination with other services.

13.3 Agreed installation drawings shall be provided to members of the design and construction team prior to work commencing. Sufficient time, as agreed with the Employer's Representative must be allowed for comments/suggestions to be offered prior to final issue. Works on site shall not be permitted until these drawings have been received, commented upon and the comments incorporated.

13.4 The Contractor co-ordinated installation drawings, builders work drawings and information will be reviewed by the client team and returned with a review code as described below. Upon receipt of such drawings bearing the client teams review code and signature, the Contractor shall immediately take such action as demanded by the review code. The review codes as referred to herein shall be defined as:

Code A Information acceptable, work may proceed in accordance with the contract and specifications, no further review necessary.

Code B Information acceptable in principle, work may proceed in accordance with the contract and specifications provided that comments annotated on drawings and/or accompanying schedules are incorporated. Incorporate comments on drawings and resubmit.

Code C Information not of acceptable standard, work may not proceed. Correct and/or provide additional intonation and resubmit for review.

14.0 Builders Work Drawings

14.1 Builders work drawings shall be provided by the Contractor prior to the commencement of the works. Such drawings shall detail work which 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. The drawings must accurately indicate the sizes and locations of all items of builders work required. As an option, a request may be made to mark out in advance on site the builders work requirements.

14.2 Builders work requirements which impose on the structural engineering design shall be checked to ensure that no detrimental effect is provided.

14.3 Requirement for pre-cast chases within the building structure shall be clearly identified in terms of location and extent.

14.4 Approval of the Structural Engineer shall be required for all fixings into concrete walls, floors, ceilings or roofs.

14.5 Fixings to steelwork shall be of the clamp type. No steelwork shall be cut, drilled or welded without authorisation from the Structural Engineer. Sketch drawings shall be submitted to the Structural Engineer for approval purposes.

14.6 All access equipment such as ladders and scaffolding shall be the responsibility of the Contractor.

15.0 Record Drawings for the Building Services Installation

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

15.2 Draft record drawings in either paper or pdf format shall be submitted for comment not less than two weeks prior of Practical Completion. A full set of drawings as follows incorporating all of the Engineer's comments shall be handed over to the Employer's Representative at Practical Completion.

- Two complete sets of prints on paper.
- One set of prints on approved plastic material showing plantroom/switchroom layouts and diagrams of main electrical connections. Each print shall be mounted in a glazed frame and hung in the room housing the relevant equipment.
- A copy of all "as installed" drawing information provided on computer disc in dxf and pdf format.

15.3 Practical Completion shall not be achieved until final copies of the drawings incorporating all the Engineers comments are received by the Employer's Representative.

16.0 Operation and Maintenance Manuals for the Building Services Installation

16.1 A draft copy of the Operation and Maintenance Manual shall be handed to the Employer's Representative for comment not less than two weeks prior to Practical Completion. A full set of two complete manuals, incorporating all the Engineers comments, shall be handed to the Employer's Representative at Practical Completion. Practical Completion shall not be achieved until final copies of the Operation and Maintenance Manual are handed to the Employer's Representative. The manuals shall comprise the following:-

- A full description of each of the systems installed, written to ensure that the Employer's staff fully understand the scope and facilities provided.
- A description of the mode of operation of all systems.
- Diagrammatic drawings of each system indicating principal items of plant, equipment, valves etc.
- A copy of all record drawings to A3 size together with an index.
- Legend for all colour coded services.
- Schedules (system by system) of plant, equipment, valves, etc., stating their locations, duties and performance figures. Each item must have a unique number cross-referenced to the record and diagrammatic drawings and schedules.
- The name, address and telephone number of the manufacturer of every item of plant and equipment together with catalogue list numbers.
- Manufacturers' technical literature for all items of plant and equipment assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
- All manufacturers' guarantees or warranties.
- A copy of all Test Certificates (including but not limited to electrical circuit tests, corrosion tests, type tests, works tests, start and commissioning tests) for the installations and plant, equipment, valves, etc., used in the installations.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Schedules of all fixed and variable equipment settings established during commissioning.
- Control sequences for all systems installed.
- Procedures for seasonal changeovers.

- Recommendations as to the preventative maintenance frequency and procedures to be adopted to ensure the most efficient operation of the systems.
- Lubrication schedules for all lubricated items.
- A list of normal consumable items.
- A list of recommended spares to be kept in stock by the Employer, being those items subject to wear or deterioration and which may involve the Employer in extended deliveries when replacements are required at some future date.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for all relevant contractors and for emergency services in a prominent position in the manual.
- The Manuals to be A4 size, in plastic covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover titled. Drawings larger than A4 to be folded and accommodated in the binders so that they may be unfolded without being detached from the rings. The manual shall clearly display on its spine and front cover its contents. All information included in the manual shall also be provided in a digital format.
- Prepare two temporary Manuals with provisional record drawings and preliminary performance data available at commencement of commissioning to enable the Employer's staff to familiarise themselves with the installation. These should be of the same format as the final Manuals with temporary insertions for items which cannot be finalised until the installations are commissioned and performance tested.

17.0 Spares

17.1 At least two weeks before Practical Completion submit to the Employer's Representative a schedule of spare parts that the Contractor recommends should be kept in stock by the Employer for maintenance of the services installations. State against each item the manufacturer's current price, including packaging and delivery to site.

17.2 Within two weeks of request submit to the Employer's Representative a quotation, priced in detail, for the initial supply of spare parts to the Employer, and including for:

- Checking receipt, marking and numbering in accordance with the schedule of spare parts.
- Referencing to the plant and equipment list in the Operation and Maintenance Manual.
- Painting, greasing, etc. and packing to prevent deterioration during storage.

18.0 Training

18.1 Before Practical Completion make arrangements with the Employer's Representative to explain

and demonstrate to the building users maintenance staff the purpose, function and operation of the installations including all items and procedures listed in the Operation and Maintenance Manual and Building Log Book.

19.0 Noise and Disturbance

19.1 In occupied buildings the use of noisy mechanical tools or equipment shall 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. Radios shall not be permitted on site.

20.0 Removal of Rubbish

20.1 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 at all times.

21.0 Site Storage and Office Accommodation

21.1 The Contractor shall supply and erect storage sheds and office huts for this portion of the work if required. The Contractor shall include for the fullest co-operation with the Employer in the use of the available storage space. Materials already delivered and stored may have to be moved and stored again in a different place before their final fixing, and to be so identified (as to include permanent labelling of the contract number applicable to the works) in order to facilitate calculation for payment of materials on site.

22.0 Fuel for Testing

22.1 The cost of any fuel and energy required for testing the installations shall be included within the costs.

23.0 Suppliers/Samples

23.1 The manufacturers/suppliers referred to within this specification are a guidance to the Contractor as to the quality of equipment to be included. The selected suppliers need not necessarily be one of those stated but the equipment offered must be of equal or greater quality than the alternatives stated at the time of tender. The Employer's Representative reserves the right to impose a specified supplier at no additional cost if the alternative offered by the Contractor is not of an equivalent standard.

23.2 Should the Contractor wish equipment produced by other manufacturers to be considered then these shall be stated within tender together with the cost adjustment over the specified item on the appropriate form.

23.3 Where the Contractor proposes the use of materials alternative to those specified he shall submit samples or other evidence of suitability. Do not confirm orders or use products until approval of samples has been obtained. Retain approved samples in good, clean condition on site for comparison with products used in the Works. Remove when no longer required.

24.0 Practical Completion and Commissioning

24.1 At an agreed reasonable time prior to Practical or Stage Completion the Contractor shall notify the Employer's Representative in writing of his requirement for inspection. This request shall be accompanied with all necessary commissioning certificates and paperwork.

24.2 The Contractor shall commission the services installations in accordance with Building Regulations, BSRIA and CIBSE compliance to meet BREEAM requirements.

24.3 At the time of inspection the Employer's Representative shall arrange for the Engineer to prepare a "snagging list" of all defective items of installation and 'sample' witness test the commissioning figures. The Contractor shall be issued with a copy of the snagging list for action and remedial works. Until such time as the Employer's Representative is notified in writing that all items on the snagging list have been attended to further inspection visits shall not be undertaken. Should any visit be abortive due to the Contractors non completion of any item previously identified monies shall be withheld from the Contractors application for payment to cover additional time spent by the Engineer.

24.4 The Contractor shall provide for the witness tests all necessary instruments and labour attendance of any specialist Contractor to prove that the installation conforms with the design and recommended guidance.

24.5 All test instruments required to demonstrate the satisfactory performance of the installation shall be supplied by the tenderer and included for within the tender sum. Calibration of all test instruments shall have been carried out within the previous 6 months by an accepted authority.

24.6 Practical Completion of the project shall not be granted until such time as all installation defects or detractions from Specification have been completed.

25.0 Building Log Book and User Guide

25.1 At Practical Completion of the project the Contractor shall provide alongside the Operation and Maintenance Manuals, and 'As Installed' drawings Building Log Book in accordance with CIBSE TM31. The Log Book shall be non technical and detail all plant settings and operation as defined by the CIBSE Guidance. In addition the Contractor shall provide a generic non technical tenant user guide detailing the equipment selection, control and operation of the plant installed by the Contractor in the tenant's demise.

26.0 Existing Supplies

Maintenance of Existing Supplies and Temporary Connections

26.1 Where it is necessary for the Contractor to disconnect any existing service, they shall notify the building management's nominated representative to obtain approval before isolating, modifying or connecting to any existing services.

26.2 It will be necessary to arrange with the nominated representative the time and date before any works to existing services are started and on each occasion that it is necessary to isolate any service.

26.3 The Contractor shall be responsible for liaison and for giving adequate warning of any intended

major isolation.

26.4 The Contractor shall be responsible for maintaining all services once disconnected and shall include in his tender for any temporary cables, equipment etc, that may be required to ensure that this is done.

Maintaining Services in Occupied Areas

26.5 The Contractor shall be responsible for keeping in working order, all times, the services in areas of the building that continue to be occupied during the works. The only exception to this shall be brief periods of isolation or disconnection which are unavoidable and for which specific dates and special working arrangements will be applicable.

26.6 The requirement to keep the services in working order shall apply equally to the existing services and to new services provided under this Contract.

26.7 Where there is loss or disruption of any services, the Contractor shall supply and install suitable temporary equipment, wiring, connections and power supplies etc., to maintain the services in operation or shall provide and set to work temporary services which afford equivalent performance and safety in the opinion of the Engineer. All these works shall be included in the Contractors tender.

Stripping Out Redundant Materials

26.8 The Contractor shall be responsible for all stripping out work required in areas where modifications are to be carried out or where equipment is indicated as redundant.

26.9 All redundant equipment unless shown otherwise shall be removed from site by the Contractor and disposed of in an appropriate manner.

26.10 The Contractor shall ascertain by site survey the extent of stripping out works and shall include for this in his tender. Claims on grounds of lack of knowledge will not be accepted.

26.11 When carrying out stripping out works the Contractor shall take care to remove only items which are not still required in the existing installations. Equipment relating to services which are to remain shall be left intact.

26.12 Any non-redundant services or equipment which are removed by the Contractor shall be replaced or made good to the satisfaction of the Engineer at the Contractors expense.

Existing Installation and Existing Materials

26.13 Where any parts of the installation are to be re-used the Contractor shall be responsible for the complete testing and inspection and of those parts, in accordance with the appropriate guidance. The Contractor shall give his full guarantee to the installation carried out using existing material or in connection with existing installation, as for new installations and shall therefore report to the Engineer immediately any parts of existing installations which are found to be defective in anyway whatsoever, and shall request further instructions.

Part B - Design Criteria

Contents

Part B - Design Criteria

1.0 System Design

General

1.1 The Contractor shall design the installation such that there is sufficient capacity for future extension/modification to each of the systems.

Available Capacity

1.2 The Contractor's design shall incorporate an allowance for the system size to be increased by 20% which if invoked at a future stage shall not cause detriment to the services installed. This shall include both the capacity of the plant selected and the physical limitations of the service runs.

Layout of Equipment and Service Runs

1.3 Layouts of all plant, service runs shall be neat, safe, accessible and logical whether in switchrooms, plantrooms, ducts, ceiling voids or elsewhere. Positions chosen shall ensure easy access for operation maintenance and inspection. The layouts shall also allow for future servicing removal and replacement of any items of equipment with the absolute minimum of disruption. Equipment shall be planned within plantrooms to provide 20% expansion space for future system enhancement.

1.4 The exposed nature of the services will need a high amount of co-ordination. The Contractor shall carry out all co-ordination and produce full co-ordinated plans and combined reflective ceiling plans prior to start on site.

1.5 Due to the nature of the Client's business, the services shall not compromise in any way the noise transmission for between spaces. All services shall pass through communal spaces and individually into each room/area, no services shall be installed between rooms. Full cross talk attenuation for ventilation shall be provided with acoustic putty pads for all electrical outlets.

2.0 Mechanical Services

Building U Values

2.1 The U-values used for the building construction shall be minimum Building Regulations at the time of construction and agreed with the Client Team.

3.0 External Design Criteria

3.1 The external conditions to be used in the contractors calculations shall generally be as follows:-

• Summer (non-cooled spaces)	dry bulb	26°C
	wet bulb	18°C
• Summer (cooled spaces)	dry bulb	30°C
	wet bulb	21°C
• Winter	dry bulb	-4°C
	wet bulb	-4°C

Part B - Design Criteria

4.0 Internal Design Criteria

4.1 The space heating and cooling systems shall be designed to maintain the internal dry resultant temperatures as scheduled below during operational periods refer also to the Room Data Sheets where provided:-

4.2 **Temperatures**

Internal office spaces	21°C +/- 2°C (Winter)	23°C +/- 2°C (Summer)
Ancillary Areas	21°C +/- 2°C (Winter)	
Toilets	21°C +/- 2°C (Winter)	No upper limit prescribed
Shower	22°C +/- 2°C (Winter)	
Plant Rooms	35°C Max	

4.3 **Relative Humidity**

Offices	Not Controlled

4.4 **Ventilation Rates**

Office Area	12litres/second/person mechanical ventilation.
Ancillary Areas	10 litres/person where mechanical ventilation.
Toilet provision	10 air changes per hour extract
Stores	6 air changes per hour extract
Plant rooms	Natural ventilation

4.5 **Population Densities**

Occupancy	Refer to floor layouts

4.6 **Heat Loads**

The mechanical services shall be designed to meet criteria based upon the following nominal heat loads:-

Office and Ancillary Spaces

Lights	10 W/m^2 maximum (sensible) or as designed
Small Power	25 W/m^2 (sensible)
People	70 W/person (sensible)
	60 W/person (latent)

Part B - Design Criteria

4.7 System Design Criteria

a) Mechanical Ventilation supply volume based on fresh air and/or heating and cooling requirements extract at 90% of supply volume. Mechanical Toilet extract volume 10 air changes per hour.

b) Infiltration for heat loss/gain as CIBSE.

c) Louvre Connections

Supply 2m/s face velocity

Exhaust 2.5m/s face velocity

d) Room Air Terminal Velocity

Mechanical Systems Ventilation and Cooling	Offices 0.25 m/s Maximum Factory 0.2 m/s Maximum below 2m

e) Noise Criteria

a. Internal, refer to Data Sheets

b. Plantroom 55 dba

c. External 40 dba at nearest open window/roof ventilation or as advised by Environmental Health

f) Ductwork Design Velocities (not Kitchen extract)

Main Ducts/Risers	-	(50% - 100% Fan Volume) 5 – 7 m/s
Branch Ducts	-	(10% - 30% Fan Volume) 4 – 5 m/s
Terminal Runs To Grilles	-	(Less than 5% Fan Volume) 2.5 – 3.5 m/s

g) Heating pipework design pressure drop – 300 Pa/m maximum 1.0m/s maximum velocity upto and including 50mm dia, 1.5 m/s maximum velocity, 65mm dia and above.

h) Cold water pipework maximum velocity 2m/s

i) Hot water pipework maximum velocity 1.5 m/s.

j) Hot and cold water simultaneous demand based on BS6700.

k) Cold water temperature 20ºC (maximum) 10ºC (nominal)

l) Hot water storage 60ºC

m) Hot water secondary return 55ºC

n) Wash hand basin and shower discharge temperature 43ºC

o) Maximum natural gas system pressure drop 1 mBar from meter or on existing systems as required to obtain required pressure at equipment.

Part B - Design Criteria

p) System margins

1) Heat emitters nett heat loss + 15%

2) HWS generation load + 20%

3) Pump and fan capacities

i) Flow rate: design + 15%

ii) Pressure development: design + 30%

5.0 System Resistance Calculations

5.1 The Contractor shall be responsible for undertaking the resistance calculation for all water and air systems to enable the selection of any necessary pumps and fans to be achieved. All resistance calculations shall include sufficient allowances to facilitate the commissioning and flow rate balancing of the system.

5.2 Where systems incorporate connection to existing equipment and plant, the information relating to the volume flow rates and resistance/pressure requirements are to be obtained from the available operating and maintenance documentation or from site validation testing.

5.3 Copies of all system resistance calculations shall be submitted to the Contract Administrator for comment prior to the final selection of all pumps and fan units.

6.0 Foul Drainage

6.1 Designs for above ground drainage system shall be based on the information provided in the following documents:-

- Building Regulations – Approved Documents
- BS EN Codes of Practice – BSEN 12056, BS6465
- Local Water Authority By-laws
- Institute of Plumbing Services Design Guide

6.2 For calculating pipe sizes the following discharge units shall apply, based on System III within BS EN 12056, for areas with higher intervals refer to BS EN 12056, as appropriate.

7.0 Water

7.1 The building water demand shall be calculated on the basis of comparable non domestic benchmark figures provided in CIBSE Guide L.

7.2 The benchmark figures relate to an Office standard without catering as follows:-

Typical Practice 9.3m³/person/year Best Practice 6.4m³/person/year

7.3 The Contractor shall achieve Best Practice levels as a minimum.

Part B - Design Criteria

7.4 All water systems in the building shall be designed to HSE Guidance to minimise the risk of bacterial growth.

8.0 Electrical Services

Electrical Design Loads

8.1 The following loads are typical values for types of space which are subject to design development, in particular the cooling loads. As part of the maximum demand calculation, diversity shall be applied to the following areas based on utilisation.

- **Office**
  - Lighting maximum 10 W/m^2
  - Small Power 25 W/m^2
  - Cooling Power 35 W/m^2 or as designed
- **Circulation Spaces**
  - Lighting 8W/m^2 Maximum
  - Small Power 2 W/m^2

9.0 Artificial Lighting

9.1 Maintained illuminances shall be provided in accordance with the requirements on the data sheets but generally as follows:-

Offices	450Lux
Circulation	200Lux
Toilets	200Lux

9.2 Calculations shall be based upon office surface illuminances

Ceiling	50%
Walls	30%
Floors	20%

9.3 The contractor shall provide luminaires/lamps to all working spaces with a minimum colour rendition of 80Ra and minimum lamp colour temperature of 4000K.

9.4 The contractor shall provide his calculations for luminaire maintenance factor based on CIBSE guidance. This shall take into account the luminaire and lamp/source type and the location of the luminaire. Assume that the cleaning intervals for luminaire and room surfaces will be two years and lamp changing (in the case of fluorescent) will be carried out every four years.

Maintenance factors proposed by the contractor in excess of 0.8 will not be permitted unless backed by suitable calculations.

9.5 Interior lighting shall be designed and installed in accordance with CIBSE Code for Interior Lighting 2006, CIBSE Lighting Guides 7 and BSEN 12464-1.

Part B - Design Criteria

10.0 Fire Alarm and Detection

10.1 The fire alarm system shall be designed to meet the requirements for a Category L2 as defined in BS5839 Part 1 2017.

10.2 This requirement needs further clarification with the Fire Engineers Report, the Insurer and Building Control. The new system shall be independent with fire & fault 2way communication to the Centre.

11.0 Enhanced Capital Allowances

11.1 The Government publishes an Energy Technology List of equipment that qualifies for the Enhanced Capital Allowance scheme. (This list can be viewed on the Government's web site www.eca.gov.uk/etl).

11.2 To enable Brethertons to claim under the scheme the contractor will be required to submit to Brethertons a separate invoice for each item of plant that appears on the ECA list.

11.3 This will be in form of:

- Contractor's invoice to Brethertons for the qualifying equipment.
- Copy invoice for the qualifying equipment from the manufacturer/supplier.
- Details of the direct cost of transport of the equipment to site.
- Direct cost of the installation of the qualifying equipment.

11.4 The list may be added to from time to time as the ECA list develops.

11.5 The contractor shall consult the Enhanced Capital allowance approved list for plant selections. Identify where this is not appropriate.

12.0 Compliance with Part L – 2013

12.1 The building and its services shall be designed, specified and installed in full compliance with Building regulations Part L2 A/B.

12.2 The mechanical and electrical contractors shall liaise to ensure that all appropriate information is accounted for within the compliance calculations.

13.0 EPC Strategy

13.1 The building shall be designed to achieve an EPC rating minimum of C.

13.2 A registered EPC shall be issued at completion.

14.0 Energy Metering

14.1 Energy sub metering shall be provided to facilitate the monitoring of 'in-use' energy consumption of major energy users in the building including (but not limited to) space heating, domestic hot water, cooling, major fans and ventilation plants, lighting, small power and any other major consumer items.

Part B - Design Criteria

15.0 Insulation

15.1 The insulant material selected for any service shall be responsibly sourced and have a low embodied impact relative to their thermal properties as determined by the 'Green Guide to Specification Ratings'.

16.0 Calculations

16.1 The Contractor shall provide all necessary calculations in support of any design information. This shall include but not necessary limited to:-

Heat Losses
Heat Gains
Duct & Pipework sizing
Ventilation Calculations
Equipment selections based on the above
Lighting Calculations
Cable Calculations
EPC BRUKL report

Part C – Electrical Services

Contents

Part C – Electrical Services

1.0 General Requirements

1.1 Protection shall be provided by means of earthed equipotential bonding and automatic disconnection of supply.

1.2 Main and supplementary equipotential bonding shall be carried out as required by the incoming supply arrangement.

1.3 All redundant existing materials shall be made safe, disconnected and removed from site.

2.0 Incoming Electrical Supply

2.1 An appropriately rated 3 phase low voltage electricity supply (in the order of 70 kVA) shall be provided terminating in low voltage switchgear appropriately rated. The Client shall place the order for the provision of the supply with the Contractor providing all liaison with WPD to ensure programme and installation are in line with contract requirements.

2.2 The Contractor shall liaise with local REC to ensure that their works are co-ordinated within the main construction programme determine the position of all their equipment prior to installing any other equipment around the service intake positions.

2.3 The Contractor shall provide, complete with meter tails, the main switch panels, as appropriate, adjacent to the metering position.

3.0 Switchgear and Electrical Distribution

General

3.1 A main distribution panel shall be installed to serve the requirements of the data sheets to provide outgoing ways for all requirements within the building and its process together with 25% spare capacity for future use.

3.2 Sub-main cables used shall be XLPE/SWA/LSF types on medium duty tray in offices.

3.3 Provide earth bars for connection of all main Equipotential bonding. All terminations on the earth bar shall be labelled detailing which part of the installation its protecting.

Distribution Boards

3.4 Distribution boards shall be of similar manufacturer to the main switchgear.

3.5 Sub circuit protection shall be M10 MCB/RCBO to all outgoing circuits contained within distribution boards. Distribution boards shall be provided with integral isolators and lockable covers.

3.6 Where appropriate RCBO units shall protect circuits.

3.7 Provide kWhr recording meters to all distribution boards in accordance with Building

Regulations.

3.8 All distribution boards shall be equipped with typewritten schedules detailing the type, use and size of MCB and all type and sizes of cables and earthing method.

Sub-Circuit Wiring

3.9 Final sub-circuit wiring shall be carried out in CU/LSF/LSF with CPC cables contained on tray through out. All cable drops shall be protected by galvanised steel conduit or feature architectural containment.

3.10 Multiple runs of cables shall be fixed to galvanised medium duty cable tray. The tray shall be surface throughout, fully coordinated with other services.

3.11 Generally wiring systems and accessories shall be surface within the building fabric and be of a black metal clad finish.

3.12 Wiring of the fire alarm system shall be carried out in soft skin fire resistant cables complete with red over sheath.

4.0 Earthing

4.1 Earthing shall be carried out in accordance with the Current Edition of BS7671 including any amendments.

5.0 Interior Lighting

5.1 The Contractor shall supply and install all new luminaires complete at the time of handover, as indicated.

5.2 LED sources shall be used throughout, all with electronic high frequency control gear. DALI dimming shall be provided to three meeting spaces only with absence control and manual dimming. Open plan areas shall be daylight dimmed.

5.3 Lighting should achieve an initial efficiency averaged over the whole building of not less than 80 luminaire lumens/circuit watt.

5.4 The office lighting shall fully conform to guidance given in CIBSE Guide LG7, Lighting for Display Screens, by flush and pendant UGR19 linear profile luminaires, finished in black to the first floor and white trim where flush.

5.5 In corridors and toilet areas surface/flush downlights shall be installed and in the case of toilets be supplemented by over mirror lights to each mirror.

5.6 Staircase lighting shall comprise, wall mounted circular “shallow” bulkheads. The luminaires shall be mounted at 1.8m AFFL and be easily accessible for maintenance. The staircase lighting shall extend to the second floor.

5.7 All switches shall be of the grid type and be 20A rated. The Contractor shall not install any

switch plates until all decorating within that area is complete.

5.8 Reception and decorative area lighting shall be by LED decorative feature pendant lighting.

5.9 Where 400V is present at switches, then phase barrier switch plates shall be installed.

5.10 WC lighting control shall be by movement sensors except for disabled toilets which shall be switched.

5.11 The Contractor shall provide a programmable lighting control system. Cellularised and open plan offices lighting shall be controlled by passive movement sensors in groups of no more than 8 luminaires. The perimeter lighting zone adjacent to windows to be automatically dimmable to the ambient light level.

5.12 All luminaires shall be selected from high quality manufacturers. Lighting levels shall conform to CIBSE Guidance but generally will be as detailed later.

6.0 Emergency Lighting

6.1 The Contractor shall supply and install the emergency lighting installation to facilitate safe escape from all areas and take into account the requirements of the local Fire and Building Control Officers.

6.2 All emergency luminaires shall provide 3 hour operation and shall be either maintained or non-maintained as required. The majority of emergency lighting shall be by self-contained power packs incorporated into the general lighting luminaires.

6.3 Each group of emergency luminaries shall be installed complete with emergency test key switches incorporated in the general lighting switch plate which switch the area. Operation of an emergency lighting test switch shall break the supply to all general lighting on that circuit.

6.4 Maintained emergency over door pictograms and external overdoor bulkheads shall have LED lamps and be installed in all escape routes, doors and changes of level/direction and include emergency luminaires over escape doors in the warehouse.

6.5 Emergency lighting to the warehouse shall be by linear fluorescent luminaires with integral emergency battery pack fixed to the lighting busbar trunking. These luminaires shall ‘double’ as security lighting. Cabling and containment to these luminaires shall be carried out as stated previously.

6.6 Emergency lighting to external faces of the building shall be co-ordinated with the building fabric and the architectural requirements.

7.0 Accessories

7.1 Accessories shall be as manufactured by Knightsbridge or Vanlight finished surface in black.

Part C – Electrical Services

8.0 Small Power

8.1 All power outlets shall be surface fixed with vertical containment via surface black painted steel conduit and surface black accessories. All drops shall be via the ceiling void on the ground floor and coordinated with tray on the upper floor. Each socket for desk power shall be c/w outboard rockers and neon indication. Each desk shall be provided with RCD integral module c/w 3 outlets.

8.2 Where trunking is specified this shall be two compartment computer (as MK2 Com) with minimum compartment size 2 x 100mm high, 50mm deep, skirting trunking shall be used to the perimeter of each space with outlets as indicated on the data sheets or a minimum of 1 x TSSO at 3m centres.

8.3 Provide industrial black finished metal clad twin switched socket outlets to the space as required by the room data sheets.

8.4 Where equipment to be fed is below worktop ie. fridge's, dishwashers etc, each socket outlet shall be controlled by an above worktop mounted isolator or fuse connection unit. The tea port shall be provided with tea boiler, fridge, dishwasher and hot water unit.

8.5 Socket outlets for cleaning purposes shall be provided as follows:-

- 1no. twin per area (adjacent to entrance door)
- 1no. twin per 100m² open plan
- 1no. twin per 10m run of corridor
- 1no. twin per floor in stairwells on main floor landing

All socket outlets shall be RCD protected and clearly labelled.

8.6 Final circuits shall be radial or ring circuits. In general all small power outlets accessible to occupants shall be protected by 30mA trip residual current devices. RCBOs shall be fitted to single pole ways within the distribution board or within the power module at the desk. All other outlets shall be protected by MCB's. All MCB protection devices shall be Type B and RCBOs shall be Type C characteristics. No more than eight twin switched socket outlets shall be connected to a single ring circuit.

8.7 Provide power and wiring systems as required by the data specialist; the fire alarm installers; the access system installer and the mechanical contractor.

8.8 Within the IT spaces provide the following within the floors for connection of IT equipment.

- Server Room - 1 x 16A SPN BS4343 + 42U rack + 3x24 way patch rack and 3 cable management bars.

9.0 Hand Dryers

9.1 The Contractor shall provide hand dryer connection points within toilets with a minimum of one per space and then at a rate of one per two additional wash hand basins. The dryer outlets shall not be mounted over equipment likely to be affected by water dropping from drying hands.

9.2 The contractor shall provide a black bodied Dryflow G-Force hand dryer to each of the hand drier connection points.

10.0 Mechanical Service Connections

10.1 The Contractor shall be responsible for wiring up to and including switches, isolators or fused connection units serving mechanical plant. Final connections from fused connection units and devices will be the responsibility of the Mechanical Contractor, unless otherwise stated. The contractor must liaise with the mechanical contractor to determine the size, position and capacity required of any power supplies required.

10.2 The Contractor shall liaise with the Mechanical Contractor to determine the exact locations of fused connection units to ensure that flexes are kept to a minimum length.

11.0 Fire Precautions

Fire Alarm

11.1 The Contractor shall employ the services of the centre specialist to design and provide a single loop open protocol analogue addressable fire alarm system with automatic detection.

11.2 A fire alarm system compliant with the requirements of the relevant British Standard and the Building Control Officer shall be installed throughout the building. This shall be of the analogue addressable type installed to Category L2 Standard.

11.3 The fire alarm shall be supplemented with VAD's for the hard of hearing.

11.4 A 16A single phase MCB shall supply the fire alarm panel. The MCB shall be red in colour. A key controlled fire isolation switch unit shall be installed adjacent the fire alarm panel. Connections between the connection unit and fire alarm panel shall be hard wired.

11.5 All detectors, sounders and manual call points shall be provided by the Contractor to comply with the requirements of Building Control and the tenants insurers complete with all associated wiring.

11.6 An address shall be given to each fire alarm device and the addresses shall be such that all devices are identified in a logical sequence and that the sequence of addresses can be easily and logically extended.

11.7 All detection heads on the first floor shall be black in finish to match the luminaire and mechanical equipment.

11.8 The Contractor shall employ the centre specialist to extend the existing landlord/centre alarm network to the unit and install suitable interface for the building to allow 2way fire and fault communication. The specialist shall link the system and commission both systems for full operation.

11.9 All components of the fire alarm system shall be by the same manufacturer, who shall fully test,

commission and demonstrate the systems upon completion.

12.0 Structured Cabling Systems (SCS) and Containment

12.1 Provide one 90mm diameter duct into the cleaners room solely for telecom access, the contractor shall liaise with the local telecom provider to connect these into the nearest external connection chamber which will supply the service to the building. The Openreach order has been placed direct by the Client for the building, however the Contractor shall fully co-ordinate the works.

12.2 The Contractor shall install a system of IT containment basket and tray throughout the building 2or the routing of IT cabling.

12.3 The systems shall route through the ceiling void and risers originating from the central or server room.

12.4 The system shall follow the general cable routes and incorporate bridging pieces to ensure that all data and adjacent power cables are run separately.

12.5 The baskets shall be a minimum of 150mm wide.

12.6 Black steel conduit from basket to the wall outlet position shall be installed to mirror the power provision..

12.7 The contractor shall employ the services of a specialist company to provide the IT infrastructure to the building as identified below.

12.8 The contractor shall include for all equipment, materials, labour and services to provide the infrastructure including, but not limited to:

Horizontal Infrastructure (Category 6 U/FTP).
Backbone Infrastructure (Optical Fibre OS1/OS2 and/or OM3/OM4) from Openreach connection to server.
Equipment cabinets, frames, racks and enclosures.
Termination frames and panels.
Multi-purpose Telecommunication Outlets.
Supply of drop cables to connect horizontal cabling to connect network services.
Generation of base line patching schedules.
Documentation and submissions.

12.9 The Contractor shall earth all installed apparatus, equipment and components to ensure equal potential is maintained through his installation in accordance with EN50174 & EN50310

12.10 The Contractor shall obtain written approval from Main Contractor and the Electrical subcontractor before any earthing connections are made on site for use by Installation prior to commencement of his connections or works.

12.11 The chosen structured cabling system are manufactured by Excel Networking or equal and approved.

Part C – Electrical Services

- A complete solution from a single manufacturer shall be provided, and shall be covered by a single 25 year warranty.
- The Contractor shall provide 'ongoing' independent compliance certification at both Channel and Component level from a trusted test establishment such as Delta Labs of Denmark. One off 'Approvals' and 'Attestations of Conformance' will not be acceptable.

12.12 All Equipment, Server and Open Racks shall be Excel Environ and covered under the Manufacturer's single warranty.

12.13 The Contractor shall apply the methodologies for installation in accordance with BS EN 50174 and following the Manufacturers Installation Guidelines these shall be used during all installation activities. Should conflicts exist in local law, codes and regulations, then local law, codes and regulations shall take precedent.

12.14 The Contractor for all Horizontal and Backbone cabling must ensure it is fully supported, contained and managed along its entire length. Cabling must be routed and secured, fixed or positioned upon designated 'Communication Containment' provided by the Electrical subcontractor.

12.15 The Contractor shall ensure the containment system is suitable and adequate under the standards of this specification and against those set by the manufacture company of the cabling system.

12.16 The Contractor shall draw up full details of the cable plant labelling scheme for every cable, patch panel, wiring closets, termination frames, and telecommunication outlets and agree the format with the Engineer prior to installation.

- Typeface Labels shall have an agreed typeface size and font. Hand-written labels will not be accepted, except on a temporary basis during installation and will not be acceptable for cable plant testing purposes.
- Characteristics All labels shall be permanently fixed. Legible, durable and robust.
- Orientation All labels shall be fixed horizontally on fixed equipment or longitudinally along the line of cables.
- Positions The following positions at which labels are fixed shall apply as a minimum:
    - Cable terminations shall be labelled at patch panel outlets.
    - Cable shall be labelled at telecommunication outlets.
    - Cables shall be labelled at the entry/exit points of rooms and buildings.
    - Cables shall be labelled at all access chamber, cable turning chambers and draw pits.

12.17 The Contractor upon detection of cable plant failures during testing shall be duly noted each failure. The Contractor shall rectify all faults any damaged cabling shall be replaced with new cables in complete runs.

12.18 The Engineer reserves the right to attend site to witness cable plant tests and complete random sample testing upon completion of test. Witness testing and random sample testing shall be agreed with the Contractor prior to commencement of site testing and will be no more than 10% of the total number of outlets, unless significant anomalies are found.

Part C – Electrical Services

12.19 The Operations and maintenance manual for the project shall be compiled in accordance with BS 6701 and shall include but not limited to the following documents. These shall be presented to the Main Contractor during bidding and on completion of the installation of the Physical Infrastructure by the Contractor:

- Current Independent 3rd Party Component Compliance Certification, indicating manufacture and component reference, for all items installed and supplied.
- Manufactures' literature for products installed.
- Uniquely number test certificates for copper and fibre optic (link and channel where appropriate) for the entire SCS Physical Infrastructure.
- Electronic records of all test results.
- SCS Physical Infrastructure warranty (25-Year).
- Warranty against defective parts or workmanship for a minimum of 1 year after Practical Completion.

12.20 The Contractor shall provide AutoCAD as-built installation drawings in which shall be handed over in paper and electronic formats upon completion detailing the following information:

- Horizontal cable routes. These drawings shall detail the number of TOs per floor, area or location.
- Backbone cabling routes. These drawings shall detail the quantity, type and routes of backbone cabling (both copper and fibre optic).
- Layout of termination frames, panels and closets, clearly identifying the number of frames or panels.
- Layout of Equipment Rooms throughout the entire project. These drawings shall identify the particular frames, panels and closets in each room.
- Telecommunication Outlet distribution. These drawings shall indicate the location and unique identifier of TOs throughout the entire project.

12.21 For acceptance of the Physical Infrastructure the Contractor shall complete the following:

- All labelling.
- All installation of Physical Infrastructure (to the correct standards).
- All cabling test results showing positive results (to the correct standards).
- All documentation.

12.22 The Contractor is to provide Training to the clients IT Staff where required in the correct method of patching and system administration. The Contractor shall allow for a suitable amount of time for onsite Training.

12.23 The Horizontal structured cabling system shall provide in strict accordance with the tender documentation. The system shall be used to connect voice and data services, WLAN, CCTV, and Access Control devices to the network. Telecommunication Outlet requirements shall be taken from the drawings or room data sheets.

12.24 The performance of the Contractors Horizontal structured system being provided shall meet ISO 11801:Ed2.2, ISO 60603-7-5, ISO 61156-5, EN 50173-1, EN50310 standards operating at frequencies up to 500Mhz, supporting Voice, Data & Video applications at data rates of up to

10Gbit/s to full 100m channel requirements. The Horizontal Category 6A compliant system must also be backwards compatible with ISO 11801:Ed2.2, ISO 61156-5, EN 50173-1:A2:2011,

The cabling must be four-pair 100 ohm Category 6 type. **The cable must have current independent third party approval status at component level and include specification references.** Horizontal cables shall be constructed with a Low Smoke Zero Halogen jacket meeting IEC 60332-1 flammability standard as a minimum. The cable must also be available in various colours including White, Violet and Orange, in case the client wishes to identify Horizontal Services by way of colour.

12.25 As a minimum the Patch Panels must:

- Be 19" rack mountable, in exact multiples of 1U in height.
- Cable terminations must be Insulation Displacement Connectors (IDC).
- Front connectors to be RJ45 style
- Label System
- Lifetime Product Warranty

The client preference for High Density Frames is:

Excel 100-181 Keystone Toolless Jacks within an Excel 100-041 0.5U patch Panel Frame, or: Excel 100-185 Keystone Toolless Angled Outlets in Excel 100-024 Unloaded Frames in the following configuration:

- Straight or Angled side-by-side Presentation of Chrome Finish
- Front connectors to be straight or angled RJ45 style
- Front presentation of Jack outlet to be angled at 45 degrees
- Rear cable presentation to be 180 degrees

12.26 Outlet Connectors:

- Cable terminations must be Toolless Insulation Displacement Connectors (IDC).
- Connector style to be RJ45
- Toolless Termination or punch down
- Lifetime Product Warranty
- Must have current independent third party approval status at component level to a minimum of ISO/IEC 11801.

The form factor of the data outlet plate shall be from the **Excel Office** range, and shall be made up of:

1 x Excel Office Single gang faceplate
2 x Excel Office White Angled Shutter
2 x Excel Category 6A Low Profile Screened Keystone Jack

12.27 The Contractor shall allow for the supply only of the following Excel Category 6 compliant Patch leads.

Each patch lead shall be complete with strain relief boot and RJ45 connector. The patch leads

must have current independent third party approval status at component level and include specification references. The Contractor shall allow for patch leads to be available for the Patching Fields, these are supplied in standard lengths.

12.28 The server room will contain a combined Equipment and Server Rack as defined within the Summary of Works.

Rack

Server Cabinet shall conform, as a minimum, to the following specification:

- Comply with ANSI/EIA-310-E,IEC60297-2,DIN41494 Part 1&7
- Fabricated from steel or aluminium.
- Colour scheme: Grey/White RAL 9002
- Overall height less than 2300mm.
- Footprint of 800x1000mm
- Capacity 42U.
- 3x24Way patch panels
- 3 cable management bars
- 4No. 19" Vertical mounting angles, each fully adjustable.
- Internal equipment mounting depth minimum of 895mm front to rear.
- Lockable Quick release front and rear doors and metal side panels.
- 'Wave Style' ventilated metal front door with 2 point swing handle CAM lock
- Ventilated metal split rear doors with 3 point swing handle CAM lock
- Minimum Load Capacity 1300Kg.
- Jacking Feet and Castors
- Baying Kit

Intelligent Power Distribution Units

Intelligent PDU's shall be installed within each Equipment Rack or Server Rack, these shall be selected according to the size and load bearing requirements, and pay particular attention to the required equipment termination plugs.

Further detail is given for typical layouts of wiring and equipment closets later in this document.

13.0 Lightning Protection

13.1 A lightning surge protection system shall be installed to the building in compliance with BS7671.

14.0 Security Systems

14.1 The Contractor shall employ a specialist to design, provide, install and commission the following security systems to the building. The specialist contractor shall be a member of NACOSS and approved by LPC.

14.2 Provide a Paxton complete access control system managed by a network PC with Windows based software to the doors indicated in the room data sheets. Provide proximity FOB readers

to the doors indicated in the data sheets together with all power supplies, electronic locks and fifty FOB's.

14.3 Each door shall be fitted with:

- Paxton P50
- Paxton Net2 door controller
- 12V 2A power supply
- Magnetic lock and fixings
- Press to exit button
- Emergency break glass

The system shall be interfaced with the fire alarm system and be released upon fire activation.

15.0 Disabled Alarm System

15.1 The disabled persons toilet alarm system shall comprise of the following:

a) Central panel and power supply unit located in the Management suite.
b) Interconnecting wiring
c) Alarm components associated with each disabled toilet
d) Alarm components associated with each refuge point intercom

15.2 Each disabled toilet shall have the following installed:

- Pull cord adjacent to each toilet
- Reset unit located inside each toilet
- Tone generator/Over door lamp.

15.3 A disabled refuge intercom system shall be installed to the stair, each refuge point shall be wired back to the security/fire control centre and shall be capable of two-way speech

16.0 Audio Visual Equipment

16.1 A screen will be installed to one of the walls in the ground floor 4 person meeting room, courtroom and 8 person meeting room. A twin power supply and dual data outlet and HDMi interface shall be provided to the rear of the screen with an HDMI input plate below.

16.2 Provide induction loops for hearing aid enhancement in each of the meeting rooms, board rooms and reception.

16.3 Provide TV aerial system with connections for future satellite/free view connections.

Part D - Mechanical Services

Contents

Part D - Mechanical Services

1.0 General Requirements

1.1 The following section of the Specification details the design intent for the mechanical services installations and the standard of materials to be used. Where specific models and manufacturers are stated these have been provided to illustrate the quality of plant and materials required and it is the responsibility of the Contractor to size and select the plant and materials to meet or exceed the standards required.

1.2 Layout of all plant, switchgear and service runs shall be neat, safe, accessible and logical whether in switchrooms, plantrooms, ducts, ceiling voids or elsewhere.

1.3 Positions chosen shall ensure easy access for operation maintenance and inspection. The layouts shall also allow for possible future removal and replacement of any items of equipment or cable with the absolute minimum of disruption.

1.4 Any existing services which are to remain untouched shall be adequately protected throughout the installation.

1.5 Where items of plant equipment are mounted, the layout shall be rationalised so as to allow additional future equipment to be installed.

1.6 All services shall be provided with 20% spare capacity for future purposes, unless otherwise stated.

1.7 Services on the ground floor are to be located within the ceiling void, as there is an MF ceiling proposed to be installed. First floor services are to be installed within the soffit zone, where no ceiling is to be installed.

Design Calculations

1.8 The contractor shall, prior to commencement on site, provide detailed calculations for the following:-

- Primary incoming water size, peak flowrate and pipework size.
- HWS and MCWS pipework demand loadings, pipework pressure drops, water velocities.
- Submission of complete water services installation and all relevant details from point of supply to point of usage to the local Water Authority.
- Mechanical ventilation unit selections, calculation of pressure drop, air volume rates for all systems, grille schedules and selections.
- Attenuator selections.
- Above ground drainage calculations.
- Heat loss and heat gain calculations.
- Air conditioning unit system selections based on heat losses and gains.

Existing Roof Top Services

1.9 The contractor is to allow for removal of any redundant mechanical plant located on the Brethertons roof plant area.

1.10 The existing plant decks/supports are to be utilised for the new plant where possible. A structural engineer is to confirm suitability.

1.11 Existing roof penetrations and risers are to be re-used for the new ductwork and pipework runs.

2.0 Incoming Services

2.1 The Contractor shall liaise with Cherwell District Council who are placing the order to provide a suitably sized mains cold water supply to serve the building from the incoming service.

2.2 The Contractor shall ensure they have incorporated the mains cold water supply within their programme of works.

3.0 Comfort Cooling Systems

3.1 The Contractor shall design, supply, install, test and commission new VRF comfort cooling systems to serve the Office areas.

3.2 The Contractor shall carry out all heat gain and heat loss calculations for each area/room. The calculations shall be carried out in accordance with the design parameters set out in this Specification, where specific parameters are not detailed current CIBSE design recommendations shall be utilised.

3.3 Heat gain calculations shall include all occupancy levels, lighting gains, equipment gains, building fabric and solar gains.

3.4 For equipment loads each workstation/desk shall include for a computer rated at 250W output in the heat gain calculations. As detailed in the design parameter section the Contractor shall also check the equipment small power gain allowance of 25W/m² for each area and utilise the largest load calculated in order to provide some in-built flexibility in system for any future office layout changes.

3.5 The Contractor shall also allow for an intermittently operated printer in the heat gain calculations for each office area/room apart from meeting rooms.

3.6 The Contractor shall determine the building fabric details for the heat gain and heat loss calculations. All calculations shall be submitted to the Contract Administrator together with design drawings in good time to allow comment prior to any equipment being ordered and works undertaken.

3.7 The Contractor shall ensure the system sizing indexing does not exceed the manufacturer's recommended minimum and maximums.

3.8 The new comfort cooling and heating systems shall be a refrigerant based circular cassette VRF type system utilising R410A refrigerant and providing simultaneous heating and cooling to the areas served. Each office area/room shall be served with its own individual circular cassette unit (as Samsung or equal and approved) and shall be individually controlled. A circular cassette unit serving two separate rooms or areas shall not be permitted.

Part D - Mechanical Services

3.9 Should an area require two circular cassettes to meet the load requirements or to provide adequate air distribution coverage, the cassettes shall be arranged to operate and control together as master and slave from the same BS box.

3.10 The circular cassettes shall be of the ceiling mounted type on the ground floor, and open soffit mounted on the first floor. The circular cassettes shall be installed on anti-vibration mountings.

3.11 The Contractor shall ensure on all cassette unit installations that full maintenance required by the manufacturer can be carried out easily.

3.12 The Contractor shall provide a condensate drainage system utilising plastic UPVC pipework to serve the cassette unit installations. The condensate lift pumps within the new coil units shall be utilised, no other condensate pumps shall be utilised in the condensate drainage system. Once leaving the fan coil units condensate drainage shall be gravity only unless this is proven to be impracticable. Condensate drainage pipework shall connect to either local rainwater down pipes or local internal gravity drainage. A Hepvo valve seal shall be provided on all connections to foul or rainwater drainage.

3.13 Refrigerant pipework for the system shall be installed through the ceiling void and open soffit areas on the ground and first floor to serve the cassette units utilising the manufacturer's recommended pipework support arrangements. BS boxes shall be positioned in the ceiling void and open soffit areas adequately supported off the building structure. All refrigerant pipework shall be insulated in accordance with the manufacturer's recommendations. The Contractor shall provide a full refrigerant pipework specification proposal prior to installation.

3.14 As part of the system the Contractor shall supply and install an Intelligent Central Controller which shall, as a minimum, have the following features.

3.15 A stand-alone central control module, the module shall be capable of controlling all fan coils. The controller shall have a liquid crystal touch screen display and provide the following facilities:-

System On/Off time control

Temperature setting

Fan speed setting

Filter cleaning signal

Auto/manual setting for heating/cooling

Master/slave settings

Self-diagnostic function

Operation mode and priority settings

Remote controller settings

Fault indication for each group and fault location and identification

Automatic heat/cool changeover

Heating optimisation and frost protection

Temperature limits

Power proportional distribution

Flexible timer function

Historical data retention

Password security

3.16 The central controller shall be positioned in the post room and shall be agreed with the client that the location is suitable. The Contractor shall programme the central controller to the Client's requirements on commissioning and shall provide a full demonstration and training in the use of the controller on completion.

3.17 The Contractor shall locate external condensing units on the roof area. Final position to be agreed on site. The condensers shall be installed upon the existing plant decks if suitable. If there is no existing deck, the condensers shall be installed on concrete bases with 20mm thick Tyco Pad supports below.

3.18 The whole comfort cooling/heating VRF system shall be designed and installed in accordance with the current FGas Regulations and the manufacturer's recommendations and details. The design and installation of the system shall be undertaken by a Contractor who is approved by the system equipment manufacturer to a level where a five year parts warranty on the system equipment and components is provided. (Samsung partner or equivalent).

4.0 Server Room Cooling

4.1 The Contractor shall design, supply, install, test and commission a split system DX cooling system to serve the Server Room on the first floor utilising R32 refrigerant.

4.2 The Contractor shall calculate heat gains to the room including an equipment load of 1.5kW.

4.3 The condensate drain shall be run from the unit to discharge into the local drainage system. The Contractor shall utilise a HEPVO drain trap seal on the connection to the drainage system.

4.4 A condensate pump shall not be used, all drains shall be gravity run only.

4.5 The Contractor shall supply and install all power and control wiring from the external condensing unit to the indoor wall mounted unit. A wall mounted controller shall be provided.

4.6 All refrigerant pipework shall be run through ceiling void areas, all pipework on view in the Server Room shall be installed in a proprietary white plastic trunking for refrigerant pipework.

4.7 The split system shall be installed and commissioned fully in accordance with the manufacturer's recommendations.

Part D - Mechanical Services

5.0 Heating System

5.1 The contractor shall design, supply, install, test and commission an electric heating system to offset the calculated heat losses within the WC's and shower. Associated electrical spur connections are to be supplied and fitted by the electrical contractor.

5.2 The shower room shall be fitted with an electric towel rail complete with associated independent controls.

6.0 Hot and Cold Water Services

6.1 The Contractor shall design, supply, install and commission new hot water services to serve the layouts indicated on the tender drawings via the use of local unvented electric hot water heaters (Zip Multi-point type or equal and approved).

6.2 The areas served shall include:

- Male and Female W.C.'s
- Disabled W.C.
- Cleaners Store
- First Floor Tea Point.

As detailed in the Room Data Sheets.

6.3 All heaters shall be installed complete with manufacturer's unvented installation kit and temperature control kit (blending valve kit). The maximum pipe run from a single water heater shall be limited to a 5m run.

6.4 Heaters shall be sized according to the outlets/appliances served in accordance with CIBSE recommendations and sizing data.

6.5 All pipework shall be copper and installed in accordance with the General Section of this Specification.

6.6 A new incoming mains cold water service shall be provided to the building and shall be distributed to serve the areas detailed above together with other supplies as detailed below.

- MCWS Supplies to the first floor boiling water tap and dishwasher.
- MCWS to serve the ground floor reception coffee machine.
- MCWS to serve the electric shower.

6.7 The design and installation shall fully comply with all current local water Authority Byelaws and Regulations.

6.8 All pipework shall be copper and installed in accordance with the General Section of this Specification.

6.9 The Contractor shall also provide the new hot and cold water services to serve the new male and female WCs and cleaners cupboard on the first floor, accessible WC on the ground floor.

6.10 All hot and cold water services pipework in ceiling voids, service ducts/boxings, where concealed from view, in plantrooms and behind kitchen units shall be thermally insulated in accordance with the General Section of this Specification.

6.11 Showers where indicated shall be electric and shall be minimum 10.5 Kw rating.

7.0 Domestic Services Water Treatment

7.1 The Contractor shall clean and sterilise the new domestic water installations in accordance with BS 6700.

7.2 The domestic hot and cold water installations shall be flushed through at least twice with clean water to remove any dirt and debris present. After flushing the systems shall be chemically sterilised in accordance with the relevant Clauses of the General Specification and to the local water Company requirements.

7.3 On completion of the chemical sterilisation of the domestic water services, the Contractor shall obtain signed certificates from the chemical treatment specialist confirming that the required sterilisation procedure has been successfully completed.

7.4 It will be the Contractor's responsibility to ensure that adequate and assessable water sampling points are provided in the pipe services to facilitate the successful completion of the chemical treatment procedures.

7.5 To reduce the risks of the re-infection of the domestic water services after sterilisation, the sterilisation procedure shall not be carried out earlier than seven days prior to the occupation of the building.

8.0 Fresh Air Ventilation

8.1 The Contractor shall design, supply, install, test and commission a supply and extract ventilation system to serve all office areas.

8.2 The systems shall comprise of supply/extract air handling ventilation unit providing fresh air for the occupancy levels of the areas. Fresh air shall be taken from the roof and delivered into occupied spaces through a range of thermally insulated galvanised sheet metal ductwork.

8.3 Extract air shall be removed from the ceiling void of each area through a range of galvanised sheet metal ductwork to discharge at roof level.

8.4 Fresh air supply ductwork and extract ductwork shall run within the open soffit areas into the existing risers and vertically upwards to intake/discharge at roof level as indicated on the layout drawings.

8.5 The roof mounted AHU shall be provided with attenuators and shall be located on the existing plant deck. Structural Engineer to confirm suitability.

8.6 Fresh air shall be delivered to the areas to provide 12 litres per second per person based on the occupancy levels detailed.

8.7 Vitiated air shall be extracted from the open plan offices via bell mouths. Any offices with ceilings are to have direct ducted ceiling extract grilles.

8.8 The air handling unit shall be as Nuaire Boxer AHU range complete with heat exchanger, frost coil and heating coil. All to current ERP Regulations.

8.9 Air intake and exhaust terminals shall be arranged to avoid short circuiting of air paths. Each terminal shall prevent the ingress of rain ad be complete with bird mesh.

8.10 Fire dampers shall be provided to maintain the fire compartmentation of the building.

8.11 The Contractor shall prove all air volumes achieved during commissioning to the Engineer at practical completion witnessing.

9.0 Toilet Ventilation

9.1 The contractor shall design, supply, install, test and commission a central toilet extract ventilation system to serve all toilet area and shower on the first floor level.

9.2 Extract ventilation shall be provided to the areas via a twin fan extract ventilation unit incorporating a trickle and boost mode of operation when activated via a time signal the unit shall operate in trickle mode until activated into boost mode which shall be achieved via a PIR detector located in each area. Once activated the PIR will run the unit in boost mode for a 20 minute period until returning to the trickle mode of operation.

9.3 Vitiated air shall be extracted from the area through a galvanised ductwork distribution system linking back to the twin fan extract unit. From the twin fan extract unit air shall be discharged at roof level. Ductwork shall enter the existing riser within the office soffit zone and rise vertically to roof level as indicated on the layout drawings. Attenuators shall be required to the twin fan extract unit to meet the noise parameters stated in the design criteria.

9.4 Extract points/grilles shall be provided to every W.C, and one grille per two urinals. Grille extract points to the shower area shall be as required to provide complete extract ventilation to the whole area.

9.5 The contractor design, supply, install and test a through the wall extract fan to serve the ground floor accessible WC.

9.6 The contractor shall provide make-up air to the areas via the lobby areas to the Male/Female W.C/Shower area via door transfer grilles.

10.0 Ductwork

10.1 The Contractor shall ensure ductwork installations are protected during the course of the works and wiped clean prior to connection to grilles and fan coils. Open ended ductwork shall be sealed at all times.

10.2 All ductwork shall be installed and manufactured in accordance with HVCA Specification DW144 and the relevant sections of the General Specification of this document.

Part D - Mechanical Services

11.0 Co-Ordination of Electrical Power Supplies

11.1 The Contractor shall fully liaise with the electrical services Contractor prior to submission of tenders to ensure power supplies are included in the electrical services tender for all mechanical services equipment including but not limited to:-

1. VRV condensing units
2. Cassette units
3. BS boxes
4. Server Room AC system
5. Extract fan units
6. Water heaters
7. Controllers
8. Electric panel heaters
9. AHU
10. Control Panels
11. Sprinkler Equipment, Pumps, Control Valves etc.

12.0 Fire Protection

Automatic Fire Sprinklers

12.1 All areas of the premises, with the exception of electrical rooms and IT services, shall be fully sprinkler protected.

12.2 The system shall be installed in accordance with LPC Rules for Automatic Sprinkler Installations incorporating BSEN 12845. There shall be no deviations from the rules, except where authorised by ACE European Group.

12.3 The contractor shall employ a sprinkler specialist to design, supply, install, test and commission a new sprinkler system to serve the ground and first floor offices.

12.4 The specialist sprinkler contractor shall extend the landlords sprinkler main from within the existing mall, to the new area.

12.5 At the end of the extended main, the sprinkler contractor shall provide two new feeds to the ground and first floor levels.

12.6 Each new feed is to be installed complete with new isolation and zone check valves.

12.7 The electrical contractor shall undertake the fire alarm works associated with the new isolation valves and zone checks.

12.8 From each new floor supply, the sprinkler contractor shall install a pipework network to serve new sprinkler heads within the office areas.

12.9 All new false ceiling sprinkler heads shall be conventional, quick response, 68°C and white finish.

12.10 All new pipework shall be made using medium weight steel tube and fittings finished in red oxide.

12.11 The sprinkler contractor shall test and commission the systems and leave the systems live.

Dry Risers

12.12 A new dry riser shall be provided to serve the proposed new Mall connection.

12.13 The new dry riser inlet box is to be located by the ground floor accessible WC wall, where it will rise internally into the ceiling void. From here it will run horizontally in the landlords service route to the outlet box in the proposed new Mall connection.

12.14 The dry riser will rise up into the first floor switchroom and run horizontally to an outlet box within the landlords circulation space adjacent to the Unit 2.

12.15 The installation shall comply with BS9990:2015. The system shall be pressure tested to 12bar. New inlets shall comprise of a two way inlet breaching valves connected to 100mm mains. The finish of the inlet box shall be determined by the Architect.

12.16 The mains shall be installed using galvanised mild steel with mechanical grooved joints.

12.17 The mains shall supply landing valves at each level. The landing valves shall be installed within a new outlet box.

12.18 The valves shall be flanged to the pipework for ease of replacement not screwed.

12.19 The highest landing valves shall be provided with an automatic air vent. The mains shall be self-draining with drain valves provided at the lowest point.

13.0 Foul Drainage Above Ground

13.1 The Contractor shall allow for the design, supply of all materials, installation and commissioning of a complete above ground sanitation system with interconnections to new below ground pipework as provided by below Ground Contractor.

13.2 Waste pipes shall connect to vertical soil vent stacks provided for each range of fittings to discharge via gravity.

13.4 Soil, waste and ventilation stacks plus horizontal high level runs associated with toilets and miscellaneous drainage gullies, channels etc shall be poly pipe acoustic poly DB pipework. Soil, waste and ventilation low-level branch pipework – UPVC/MUPVC to BS 4514 and 5255.

13.5 All drainage pipework shall be fitted with an intumescent fire sleeve where it passes through fire barriers.

Part D - Mechanical Services

13.6 Where there is a requirement to install Interceptors on all foul outfalls prior to leaving the building. All Interceptors shall be properly ventilated to atmosphere.

13.7 The pipework stacks and risers shall be installed from ground level up to roof level where it terminates with ventilation to atmosphere. The below slab drainage shall be by others. The Contractor shall liaise with the Ground Works Contractor and co-ordinate the interface between the above and below slab drainage points. The joints between he above and below ground drainage systems shall be made using a proprietary fitting.

13.8 Where possible soil vent stacks shall be combined at high level to reduce penetrations through the roof.

13.9 Offsets in the soil vent stacks shall be avoided wherever possible. Where soil vent stacks are offset, ventilation pipes shall be connected both above and below the bends in the offset in the soil vent stack.

13.10 Offsets at the base of stacks shall be installed using two 45 degree bends or one 90 degree bend, either of which shall be long radius.

13.11 Rodding access shall be provided at the ends of all branch pipework, at every change of direction, immediately above branch connections to the main soil vent pipes and immediately above final connection to the below ground drainage points. Rodding access to the WC floats shall be above the flood level of the WC. The Contractor shall liaise with the architect to ensure all rodding eye access panels are in the appropriate locations.

13.12 The Contractor shall install temperature and pressure relief drain connections to the SVP's via a HepVo waterless trap, or similar, as shown on the drainage layouts.

13.13 The Contractor shall install all sanitary fittings including making good of all traps and waste fittings etc. as recommended by the manufacturers. Seal all sanitary fittings to adjacent surfaces with silicone sealant as directed by the architect. When delivered check all sanitary fittings and accessories, and reject and damaged or defective items. Protect all sanitary fitting sand associated items and hand over on completion of the works in a clean and undamaged condition. Refer to the architect's documentation for details of the sanitary ware schedule.

13.14 The Contractor shall provide plant room floor gully locations and requirements to the below ground drainage contractor.

13.15 Stub Stacks are to be installed as shown on the above ground drainage drawings complete.

13.16 Soil and waste stacks shall be generally located as shown on the drawing layouts with branch connections at floor level receiving the discharge from the various sanitary appliances.

13.17 Anti-siphon and ventilation pipes shall be provided as shown on the above ground services layouts to prevent the loss of water traps.

13.18 Access shall be provided at all changes of direction, branches and connections to the suspended drainage system or drainage pipework that offsets within the ceiling void.

13.19 All soil and vent pipes shall be located in accessible positions for future maintenance. Soil

and vent pipe work within ceiling voids shall be minimised wherever possible.

13.20 All soil and vent pipe work within false ceilings and enclosures shall be insulated to meet acoustic requirements as outlined by the architect.

14.0 Attenuation

14.1 The contractor shall design, supply and install attenuators as per the layout drawings, to serve the roof top ventilation plant.

14.2 The contractor shall install crosstalk attenuators where ductwork passes into offices with ceilings, to prevent noise transmission in and out of these offices, as indicated on the layout drawings.

14.3 The attenuators are to reduce noise transmission from the roof plant into the building, to a standard to be agreed with the Architect.

Part E - Building Services Room Data Sheets

Room Designation	Ground Floor					
	Welcome Lobby	**Stairs/Circulation Areas (Landlord)**	**Reception**	**Circulation**	**Client Lounge**	**4 Person Meeting Room (X1) (With Glazed Face)**
Electrical Services						
Lighting Reference	A	A	B, C + R	S	B + R	P
Lighting Type	Decorative Circular Wall Mounted Luminaire in White Finish with 4000K LED and internal Microwave Control	Decorative Circular Wall Mounted Luminaire in White Finish with 4000K LED and internal Microwave Control	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover + Decorative Suspended LED Pendants with Decorative LED Lamps + Black Track with LED floods	Square LED downlight 4000K	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover + Decorative \led downlight	Flush LED Linear Fittings finished in Black with UGR19 microprism cover
Illuminance (lux)	150	150	400 + 100 for the Decorative	150	250	300
Emergency Lighting	Yes - Internal	Yes - Internal	Yes - Internal	Yes - Internal	Yes - Internal	Yes - Internal
Switching	Internal MW Sensor	Internal MW Sensor	PIR in Presence	PIR in Presence	PIR in Presence	PIR in Presence
13Amp Outlet No. (T=Twin; S=Single; USB=c/w integrated USB)	Cleaners Only	Cleaners Only	3T to Desk + Cleaners	Cleaners	2TU to Lobby Wall + cleaners	2TU to Lobby Wall + cleaners
13Amp Fuse Con Unit/Power Supplies	None	None	To Suit Mechanical and Fire Alarm Panel	None	Coffee Station and Water Cooler + Mechanical	Mechanical Plant
Network Outlet (Cat 6) (T=Twin; S=Single)	None	None	1T	2S for WIFI	Wifi Access Only	Wifi Access Only
Access Control	Main Door and Stair Door. External Door assumed to be via Key	Door at First Floor	Client Door	Side Door	None	None
CCTV	None	None	None	None	None	None
Intruder System	Yes Door contact to Brethertons Door and PIR to cover the space	Yes Door contact to Brethertons Door and PIR to cover the space	Door Contact and PIR to Client Door	Door Contact and PIR to Side Door	None	None
Fire Detection Type	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2
Comments						
Mechanical Services						
Heating Type	None	None	VRF Cassettes	None	VRF Cassettes	VRF Cassettes
Heating Temp °C	None	None	21	None	21	21
Cooling Type	None	None	VRF Cassettes	None	VRF Cassettes	VRF Cassettes
Cooling Temp °C	None	None	23	None	23	23
Occupancy	None	None	1	None	1	4
Services NR Rating (dB)	None	None	35	None	35	35
Cold Water	None	None	None	None	Yes to Coffee Station and Water Cooler	None
Hot Water	None	None	None	None	None	None
Ventilation Type	None	None	Supply and extract from central AHU.	None	Supply and extract from central AHU.	Supply and extract from central AHU.
Mechanical Ventilation Rate	None	None	12 l/s/p	None	12 l/s/p	12 l/s/p
Comments						

Room Designation	Ground Floor				
	3 Person Meeting Room (X2)	**2 Person Meeting Room (X1)**	**4 Person Meeting Room (X1) (Internal)**	**WC**	**Cleaners Store (services Intake)**
Electrical Services					
Lighting Reference	P	P	P	A	F
Lighting Type	Flush LED Linear Fittings finished in Black with UGR19 microprism cover	Flush LED Linear Fittings finished in Black with UGR19 microprism cover	Flush LED Linear Fittings finished in Black with UGR19 microprism cover	Decorative Circular Wall Mounted Luminaire in White Finish with 4000K LED and internal Microwave Control	Surface Functional LED Bulkhead
Illuminance (lux)	300	300	300	200	250
Emergency Lighting	Yes - Internal	Yes - Internal	Yes - Internal	Yes - Internal	Yes - Internal
Switching	PIR in Presence	PIR in Presence	Dali Manual Dimming with PIR in Absence seting	Internal MW Sensor	Manual
13Amp Outlet No. (T=Twin; S=Single; USB=c/w integrated USB)	2TU to Lobby Wall + Cleaners	2TU to Lobby Wall + cleaners	2TU to partition Walls + 1T to rear of TV + 1T to wall Mounted PC + Cleaners	None	1T
13Amp Fuse Con Unit/Power Supplies	Mechanical Plant	Mechanical Plant	Mechanical Plant	Hand Drier point + WC Alarm system	To Suit Plant
Network Outlet (Cat 6) (T=Twin; S=Single)	Wifi Access Only	Wifi Access Only	1T to Rear of Wall Mounted PC + 1T to rear of TV + Wi-Fi access	None	None
Access Control	None	None	None	None	None
CCTV	None	None	None	None	None
Intruder System	None	None	None	None	None
Fire Detection Type	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2
Comments			HDMI Cable \link from Wall Mounted PC to TV		
Mechanical Services					
Heating Type	VRF Cassettes	VRF Cassettes	VRF Cassettes	Electric panel heaters	None
Heating Temp °C	21	21	21	21	None
Cooling Type	VRF Cassettes	VRF Cassettes	VRF Cassettes	None	None
Cooling Temp °C	23	23	23	None	None
Occupancy	3	2	4	1	None
Services NR Rating (dB)	35	35	35	40	40
Cold Water	None	None	None	Yes to serve wash hand basin	Yes to serve cleaners sink
Hot Water	None	None	None	Yes, point of use store.	Yes, point of use store to serve cleaners sink
Ventilation Type	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.	Extract	Extract
Mechanical Ventilation Rate	12 l/s/p	12 l/s/p	12 l/s/p	10 ACH or to meet Building Regulations Part F	6 ACH
Comments					

Room Designation	First Floor						
	Open Plan Office	**Soft Seating Area (x2)**	**Kitchen and Café Area**	**Quiet Room (x2)**	**Print Zone**	**Vitual Court Room**	**Post Room**
Electrical Services							
Lighting Reference	D	D	G + H + J	D	D	D	D
Lighting Type	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED circular Fittings with Opal Base and cloth shade + Decorative LED Pendant over tea point area + LED profile to below wall cupbaords and to kickboards	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover
Illuminance (lux)	450	300	200 to Seating and 300 to tea point	400	400	400	300
Emergency Lighting	Yes - Internal (0.5Lux Min)	Yes - Internal (0.5Lux Min)	Yes	Yes	Yes	Yes	Yes
Switching	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence	Dali Manual Dimming with PIR in Absence seting	Surface PIR in Presence
13Amp Outlet No. (T=Twin; S=Single; USB=c/w integrated USB)	3S per Desk Station via On furniture Desk Module with RCD Integral and Wall Sockets. Vertical Dado to align with desk locations + Cleaners	1TU per Area	3T to Tea Point above Worktop + 1 wall 1TU to each Seating Area + 12S to Workstations via vertical power poles + Cleaners	1TU to dividing Partition Wall + Cleaners	2T to Rear Partition Wall + Cleaners	2TU to Partition Walls + 1T to Rear of TV + 1T to Wall Mounted PC + Cleaners	2 Compartment Dado Trunking Installed above Benching with 6T + Cleaners
13Amp Fuse Con Unit/Power Supplies	To Suit Plant	To Suit Plant	Tea Boiler, Fridge, dishwasher and undersink hot water storage unit	To Suit Plant	To Suit Plant	To Suit Plant	To Suit Plant
Network Outlet (Cat 6) (T=Twin; S=Single)	1S per Desk Station Via Wall Mounted Outlets + 2S to Ceiling WIFI Points	Wi-Fi Access	4S to Workstations + Wi-Fi Point/Access	1S-+ Wi-Fi access	1T-+ Wi-Fi access	1T to Rear of Wall Mounted PC + 1T to rear of TV + Wi-Fi access	2T in Dado Trunking + WIFI Access
Access Control	Yes to Stair Door	None	None	None	None	None	None
CCTV	None	None	None	None	None	None	None
Intruder System	Door Contact to Stair Access Door + PIR Coverage to Perimeter	PIR Coverage to Perimeter	None	None	None	None	None
Fire Detection Type	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2
Comments						HDMI Cable \link from Wall Mounted PC to TV	
Mechanical Services							
Heating Type	VRF Cassettes	VRF Cassettes	VRF Cassettes	VRF Cassettes	Secondary heating from Open Plan Office	VRF Cassettes	21
Heating Temp °C	21	21	21	21	As per open plan office	21	Electric panel heater
Cooling Type	VRF Cassettes	VRF Cassettes	VRF Cassettes	VRF Cassettes	Secondary cooling from Open Plan Office	VRF Cassettes	None
Cooling Temp °C	23	23	23	23	As per open plan office	23	None
Occupancy	32	2	15	1	Transient	6	1
Services NR Rating (dB)	40	40	45	30	None	30	40
Cold Water	None	None	Yes, to serve kitchen sink, dishwasher, and tea boiler.	None	None	None	None
Hot Water	None	None	Yes, from undersink store to serve kitchen sink.	None	None	None	None
Ventilation Type	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.	Supply and extract from central AHU.
Mechanical Ventilation Rate	12 l/s/p	12 l/s/p	Extract to comply with Building Regulations Part F. 12l/s/p fresh air	12 l/s/p	12 l/s/p	12 l/s/p	12 l/s/p
Comments			Kitchen/Café appliance heat loads to be included in FCU sizing calculations		Printer heat output to be taken into consideration when calculation cooling loads for the open plan office.		

Room Designation	First Floor						
	Server Room	**8 Person Meeting Room**	**Female WC**	**Male WC**	**Shower**	**Secondary Stairs/Circulation Areas (Landlord)**	**Cleaners Store**
Electrical Services							
Lighting Reference	D	D	K	K	F	L	F
Lighting Type	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	Suspended LED Linear Fittings finished in Black with UGR19 microprism cover	surface LED downlight finished in Black	surface LED downlight finished in Black	IP55 Surface LED Functional Surface Bulkhead	Anti Vandal LED Surface anti Corrosive Luminaire	IP55 Surface LED Functional Surface Bulkhead
Illuminance (lux)	300	400	200	200	250	150	150
Emergency Lighting	Yes	Yes	Yes	Yes	Yes	Yes - Internal	Yes - Internal
Switching	Manual	Dali Manual Dimming with PIR in Absence seting	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence	Surface PIR in Presence
13Amp Outlet No. (T=Twin; S=Single; USB=c/w integrated USB)	1 x 16A SPN BS4343 socket for rack + 42U rack + 3 x 24way Patch Rack + 3 cable Management Bars	2TU to Partition Walls + 1T to Rear of TV + 1T to Wall Mounted PC + Cleaners	None	None	None	None	1T
13Amp Fuse Con Unit/Power Supplies	Dedicated Distribution Board with Clean Earth To Suit Plant	To Suit Plant	Hand Driers x2	Hand Driers x2 + Cisternmiser	9kW Electric DDA Compliant Electric Shower with Raise/Fall rail	None	To Suit Plant
Network Outlet (Cat 6) (T=Twin; S=Single)	1T + WIFI Access	1T to Rear of Wall Mounted PC + 1T to rear of TV + Wi-Fi Point/Access	None	None	None	None	None
Access Control	None	None	None	None	None	None	None
CCTV	None	None	None	None	None	None	None
Intruder System	None	None	None	None	None	Door contact to escape door and PIR coverage to Internal Space	None
Fire Detection Type	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2	To Building Regulations Requirement Minimum level L2
Comments	Client to Provide 2 Rack Mount UPS Units to the Rack	HDMI Cable \link from Wall Mounted PC to TV					
Mechanical Services							
Heating Type	None	VRF Cassettes	Electric Panel Heater	Electric Panel Heater	Electric Panel Heater	None	None
Heating Temp °C	None	21	21	21	21	None	None
Cooling Type	Designated server wall mounted unit	VRF Cassettes	None	None	None	None	None
Cooling Temp °C	TBD	23	None	None	None	None	None
Occupancy	None	8	3	3	1	None	None
Services NR Rating (dB)	None	35	40	40	40	None	None
Cold Water	None	None	Yes, to serve WCs and wash hand basins.	Yes, to serve WCs and wash hand basins.	Yes, to serve instant shower.	None	Yes, to serve cleaners sink
Hot Water	None	None	Yes, to serve wash hand basins via undersink storage hot water storage units.	Yes, to serve wash hand basins via undersink storage hot water storage units.	From electric shower	None	Yes, from point of use store to serve cleaners sink
Ventilation Type	None	Supply and extract from central AHU.	Extract	Extract	Extract	None	Extract
Mechanical Ventilation Rate	None	12 l/s/p	10 ACH or to meet Building Regulations Part F	10 ACH or to meet Building Regulations Part F	10 ACH or to meet Building Regulations Part F	None	6ACH
Comments	Server equipment has a heat load of 1.5kW						

Part F - Schedules

Contents

Part F - Schedules

The Contractor shall use the following manufacturers or equal and approved in preparation of his costs, design, tender and installation.

1.0 Mechanical Services Installation

Manufacturers/Suppliers

1.1 Water Heaters

ZIP
Heatrae Sadia
HYCO

1.2 Air Handling Units

Nuaire
Flaktwoods

1.3 Extract Fans

Nu Aire
Flaktwoods

1.4 Grille and Diffusers/Door Transfer Grilles

Gilberts
Waterloo

1.5 Attenuators

Allaway Acoustics

1.6 Valves

Hattersley
Crane

1.7 Sprinklers

Hall and Kay Fire Engineering
Contact: Phil Weston
Tel No: 07736 977398

1.8 Electric Heating

Creda
Dimplex

Part F - Schedules

1.9 Controls (A/C)

Samsung

1.10 Air Conditioning

Samsung Air Conditioning
Contact: Mark Chattwood
Tel No: 07813 709478

1.11 Soil and Vent

Poly Pipe

Part F - Schedules

2.0 Electrical Services Installation

Manufacturers/Suppliers

2..1 MCCB Panel Boards and Distribution Boards

Groupe Schneider
MEM
ABB
Hagar

2.2 Sub-Main and Final-Circuit Cables

BICC
AEI

2.3 Lighting Manufacturers (Internal and External)

Premier Lighting
Back Grove Farm
Bulls Lane
Wishaw
Sutton Coldfield
B76 9QN

2.4 Accessories Range – Black Finish

Varilight
Knightsbridge

2.5 Fire Alarm

Tranter Fire & Security
The Red House
High Street
Oadby
Leicester
LE2 5DE
Tel No: 0116 271 1910
Contact: neil@tranterfire&security.co.uk

2.6 Dado Trunking (2 Compartment)

MK Limited – Prestige Range – Charcoal Finish

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2.7 Trunking/Communications Basket/Tray

Davis Trunking
Salamandre
Arena
Swifts

2.8 Earth Bars & Lightning Protection

Omega Furse
Best

Part F - Schedules

3.0 Drawing Schedule

This specification shall be read in conjunction with any drawings prepared by the Architect, Structural Engineer, any Project Specialists drawings and documentation and the following drawings by Bennett Williams.

Existing and Indicative Roof Mechanical and Electrical Services	11633-ME-001
Indicative Ground Floor Lighting Services	11633-E-001
Indicative First Floor Lighting Services	11633-E-002
Indicative Ground Floor Power and Ancillary Services	11633-E-003
Indicative First Floor Power and Ancillary Services	11633-E-004
Indicative Ground Floor Ventilation Services	11633-M-001
Indicative First Floor Ventilation Services	11633-M-002
Indicative Ground Floor Heating and Comfort Cooling Services	11633-M-003
Indicative First Floor Comfort Heating and Comfort Cooling Services	11633-M-004
Indicative Ground Floor Domestic Hot and Cold Services	11633-M-005
Indicative First Floor Domestic Hot and Cold Services	11633-M-006
Indicative Ground Floor Above Ground Drainage Services	11633-M-007
Indicative First Floor Above Ground Drainage Services	11633-M-008

Part F - Schedules

4.0 Luminaire Schedule

The following represents the style of luminaire to be used in each location as identified in the room data sheets. Not all luminaires featured below may be required on this project.

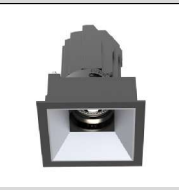
BENNETT WILLIAMS
BUILDING SERVICES CONSULTANTS

Project Title	Project Castle - Breathertons	**Prepared By**	RNP
Project Reference	11633	**Dated**	27-Sept-21
Revision	T1	**Checked By**	
Dated	27-Sep-21	**Dated**	

Luminaire Schedule

Luminaire Reference	Luminaire Description	Dimensions	Manufacturer	Area Designation	Image
A	White Body and opal diffuser decorative LED surface mounted luminaire, 4000K, integral senor and emergency	Dia (mm): 304 Depth (mm): 106	Hacel - Pebl	Lobby and stairs	
B	Decorative curve LED suspended black finished LD luminaire, 4000K with Opal diffuser	Width (mm): 371 Length (mm): 1500 Depth (mm): 85	Synergy Polaris S - 1500	Reception Area and Lounge	
C	Decorative suspended LED feature pendant, 3000K with Crystal/Glass finish	Width (mm): 120 Length (mm): 1100	Eglo Lighting - Cabezola	Reception Desk	
D	Black Bodied Linear LED suspended profile with UGR19 microprism cover,4000K, Dali digital dimming to meeting spaces	Width (mm): 82 Length (mm): 1200 Depth (mm): 89	Synergy Polaris 1 UGR19	Office and Meeting room Areas	
F	Functional IP65 white body surface luminaire	Dia (mm): 272 Depth (mm): 91	Robus - Eagle	Shower and Stores	

G	LED corner Profile with opal cover, 4000K	Width (mm): 16 Length (mm): TBC Depth (mm): 16	Maxilux - ALU03P	Tea point wall cupboard and kickboard	
H	Decorative LED Pendant and Cage	Width (mm): 160 Length (mm): 1100	Eglo Lighting - TB Newtown	Tea point	
J	Decorative Black finish fabris shade Pendant with LED 3000K decorative lamp	Width (mm): 500 Length (mm): 1100	Eglo Lighting - Marasales Pendant	Tea Point soft seating area	
K	Decorative Black finish surface LED downlight, 4000K	Dia (mm): 232 Depth (mm): 98	Synergy - Axiome Surface LED	WC Areas	
L	IP65 anti vandal corrosion resistant luminaire	Width (mm): 77 Length (mm): 1200 Depth (mm): 85	Robus - Sultan	Rear Stairs and back of house	
M	Decorative LED Surface Downlight	Dia (mm): 90 Length (mm): 200	Neko Lighting - MIU	Lounge	

P	Linear LED Flush profile with UGR19 microprism cover and white trim ,4000K, Dali digital dimming to meeting spaces	Width (mm): 82 Length (mm): 1200 Depth (mm): 89	Synergy Polaris 3 UGR19	Office and Meeting room Areas	
R	Black Mains Track Lighting c/w Black Body LED flood ,4000K,	Width (mm): 40 Length (mm): 1200 Depth (mm): 40	Gamma Lighting - Track + Jingo Spot	Reception	
S	Decorative Flush Square LED 4000K Downlight, with Black body and matt reflector	Width (mm): 68 Length (mm): 68 Depth (mm): 98	Neko Lighting - Sense 68	Circulation - Ground	

*An ‘e’ following a luminaire reference indicates emergency conversion unit, with either integral or remote application using either general lamp or EM-LED

*All LED downlights to have independent LED driver

Dali Lighting dimming control to the meeting rooms via local cat5e touch plate.

Return Tender Documents

Part G1 - Electrical Services

Contents

Return Tender Documents

Part G1 - Electrical Services

1.0 Schedule of Alternative Materials

Description of Specified Material	Proposed Alternative			
	Manufacturer	Catalogue No. and Details	Total Contract +	-

THIS SCHEDULE OF ALTERNATIVE MATERIALS TO BE COMPLETED AND RETURNED

Return Tender Documents

Part G1 - Electrical Services

2.0 Tender Summary

ITEM	DESCRIPTION	£
1.0	Compliance with Part A.	
2.0	Supply authority liaison in respect of - Electrical supply - Openreach connection	
3.0	Supply and installation of main distribution boards and final sub-circuit wiring.	
4.0	General - Earthing.	
5.0	Provide general lighting installation.	
6.0	Provide emergency lighting installation.	
7.0	Provide small power installation.	
8.0	Mechanical wiring and attendance on other Contractors.	
9.0	Supply and installation of fire alarm systems. - Tenant System - Landlord System	
10.0	Supply and installation of disabled persons alarms.	
11.0	Supply and installation of network system and wireways.	
12.0	Provide lightning surge protection equipment.	
13.0	Testing and Commissioning of general electrical installation.	
	TOTAL	_____

Return Tender Documents

Part G1 - Electrical Services

For and on behalf of .....

Address .....

.....

Signed .....

Date .....

Designation .....

Return Tender Documents

Part G2 Mechanical Services

Contents

Return Tender Documents

Part G2 Mechanical Services

1.0 Schedule Of Alternative Materials

Description of Specified Material	Proposed Alternative			
	Manufacturer	Catalogue No. and Details	Total Contract +	Total Contract -

THIS SCHEDULE OF ALTERNATIVE MATERIALS TO BE COMPLETED AND RETURNED

Return Tender Documents

Part G2 Mechanical Services

2.0 Tender Summary

ITEM	DESCRIPTION	£
1.0	Compliance with Part A.	
2.0	Supply authority charges and liaison costs in respect of provision of :-	
	i) Water Supply	
3.0	Supply and installation of VRF heating/cooling systems and ancillaries.	
4.0	Supply and installation of electric heating and ancillaries to serve WC areas.	
5.0	Provide cooling to Server Room.	
6.0	Supply and installation of domestic water installations and ancillaries.	
7.0	Supply, installation and wiring of control systems.	
8.0	Supply and installation of fresh air ventilation equipment and ancillaries.	
9.0	Supply and installation of extract ventilation systems and ancillaries to serve WC areas.	
10.0	Supply and installation of above ground drainage systems and ancillaries.	
11.0	Testing/Commissioning/Chlorination of domestic hot and cold water Services.	
12.0	Supply and installation of attenuation and ancillaries.	

2.0 Tender Summary/Cont'd

ITEM	DESCRIPTION	£
13.0	Supply and installation of sprinkler systems and ancillaries.	
14.0	Testing and commissioning of ventilation services.	
15.0	Testing and commissioning of above ground drainage systems.	
16.0	Testing and commissioning of sprinkler systems.	
17.0	Testing and commissioning of electrical services associated with mechanical services.	
18.0	Supply and installation of insulation to piped services.	
19.0	Supply and installation of insulation to ducted distribution system.	
20.0	Supply, Installation and testing of dry riser service and ancillaries.	
21.0	Contingency.	10,000:00
	TOTAL	

Return Tender Documents

Part G2 Mechanical Services

For and on behalf of .....

Address .....

.....

Signed .....

Date .....

Designation .....

BENNETT WILLIAMS

BUILDING SERVICES CONSULTANTS

Electrical Services Standards

And

Workmanship Clauses

Date:	September 2021
Ref	11633/MES/1
Issue:	T1

Contents

Contents

ELECTRICAL SERVICES STANDARD AND WORKMANSHIP CLAUSES

1.0 General

1.1 This section of the Specification prescribes the minimum standard requirements for materials and installation practice. Where clauses conflict with other parts of the specification or drawings the most onerous clause shall be deemed to have been included. Certain Clauses may not be relevant to particular contracts, and should therefore be disregarded.

1.2 All the works carried out within this contract shall be in compliance with the latest conditions of the following standards:

i) Construction (Design and Management) Regulations
ii) All Statutory Regulations
iii) Health and Safety at Work Act
iv) Offices and Shops and Railway Premises Act
v) Relevant British and European Standards and Codes of Practice
vi) Supply Authority Guidance and Recommendations
vii) Electricity at Work Regulations
viii) Trade Association Guidance
ix) Electricity (Factories Act) Special Regulations
x) The latest edition of BS7671 Wiring Regulations
xi) Manufacturers installation guidance and recommendations
xii) Disability Discrimination Act

2.0 Shock Notices

2.1 Provide adjacent to each main switchgear position, distribution board or group of distribution boards a notice indicating emergency resuscitating techniques. The exact type of notice shall be agreed with the Engineer before ordering.

3.0 Electricity Supply Intake Arrangement

3.1 The electrical supply to this development/project shall be as provided by the local supply company. Provide all necessary fuse gear/MCCB switchgear to provide the required power distribution and be responsible for co-ordinating all works at the main intake position to ensure that the supply authority is aware of the main switchgear layout so that termination and metering equipment may be acceptably accommodated.

3.2 The earthing arrangement shall be appropriate to the type of supply arrangement provided by the supply company. Sizes of earthing conductors shall be as stipulated by the supply authority and shall comply with the current Wiring Regulations (BS 7671).

4.0 Low Voltage Switchboards

4.1 Prior to manufacture of switchboards general arrangement drawings shall be produced and submitted for comment indicating principal dimensions, fixings, connections, internal and external layout details, labelling and any other relevant details.

4.2 Where original drawings are used they shall be specific to the relevant works and all references to optional features etc. shall be deleted or the original drawings re-drawn to comply with this clause.

ELECTRICAL SERVICES STANDARD AND WORKMANSHIP CLAUSES

4.3 Switchboards shall be factory assembled and tested before erection on site. Duplicate copies of the Manufacturers Test Certificate for the completed board shall be submitted.

4.4 Switchboards shall be of a metal folded and welded construction, each section being provided with suitably reinforced lifting points and be capable of being extended at either end, in compliance with Form 4 type 2 minimum.

4.5 Switchboards shall be complete with cable boxes, compression glands, wiring, glands, cable connectors, fixing bolts and all sundries.

4.6 The switchboards shall be front and/or rear access to the equipment for cabling, as specified and shall be designed to withstand a short circuit fault of 50kVA, for one-second minimum.

4.7 Switchboards shall be floor mounted with adequate facilities for holding down bolts.

4.8 All metalwork used in construction of the switchboard shall be cleaned of all scale and rust before painting and the panel and frame shall receive a minimum of one coat of primer and two finishing coats.

4.9 All doors and removable panels shall be gasketed to make the cubicles dust-proof.

4.10 All sections of the switchboard shall be effectively earthed including doors and removable plates. Earth studs shall be provided on all sections prior to the painting to ensure good continuity. These shall take the form of bolted connections. The use of hinges etc, for earth continuity is not acceptable. Multiple section panels shall be provided with an exposed copper busbar installed between sections.

4.11 Bonding conductors shall not be less than 4mm² copper.

4.12 All insulating and constructional materials and components shall be non-hygroscopic, not be readily combustible and shall be completely suitable for temperatures that may occur within the switchboard.

4.13 All units, controls, switches indicator lamps, push buttons, etc. shall be identified to indicate their duty.

4.14 Ancillary fuses and/or auxiliary relays shall be clearly identified by means of a permanent label giving function and operating details, including fuse type and rating where required.

4.15 Auxiliary wiring shall be numbered in a logical sequence by permanent slip-on ferrules; terminal blocks and terminations shall be similarly identified. 'As Fitted' wiring diagrams, numbered in accordance with the numbering scheme, shall be provided for maintenance purposes.

4.16 Connections from the busbars to the outgoing service devices shall be rated to the maximum rating of the device, no de-rating shall be allowed.

4.17 Busbars shall be totally enclosed within their own section of the panel, no other wiring shall be routed through this section.

4.18 Interlocking circuitry carrying voltages generated elsewhere shall be carried out in orange coloured cable and terminated into DIN type terminal rails within the switchboard marshalling section and kept separate from their terminations with appropriate warning notices fitted.

4.19 Wiring shall be routed through a suitably sized proprietary trunking to avoid bunching and hence adverse heating effects. Wiring to doors etc. shall be protected and supported to avoid overstressing. Where panels are to be designed for live connection all terminals shall be shrouded.

4.20 Moulded case circuit breakers (MCCB) shall be selected to withstand the system short circuit fault level at its points of installation.

4.21 MCCB's shall be supplied complete with adjustable thermal and magnetic tripping characteristics that shall be concealed under normal operating conditions. A visual mechanical indicator shall be provided to show clearly the state of the MCCB (open/closed). Facilities shall be provided for locking in the open position the MCCB.

4.22 All fuse switches shall have a minimum rating AC 23 and short time withstand current suitable for the short circuit fault level at its point of installation.

4.23 The front covers of fused switches shall be interlocked such that the cover cannot be opened with the switch in the 'ON' position.

4.24 Fuses where used shall be of the high rupturing capacity (HRC) type. Fuses shall be mounted in the insulated fuse carriers accessible from the front of the panels. The bases shall be of the fully shrouded type. Where used in fuse switches they may be bolted type and unshrouded when the fuse switch is door interlocking.

4.25 Adjacent to each switchboard shall be provided circuit schedules, they shall be typed or printed on paper, mounted on 2mm thick card, protected by clear plastic envelopes, and fixed in or local to the switchboard. Details shown shall include the location and nature of the load, number of points, fuse or circuit breaker rating, load details or horsepower, cable sizes for the supply, outgoing circuits and the source of supply.

4.26 The ways referred to in the circuit schedule must be clearly identified on the switchboard.

4.27 Upon completion of the works, rubber mats shall be provided and installed in front of and, where rear access if provided, behind each main switchboard. The mats shall run the full length of the switchboard.

5.0 Low Voltage Switchgear and Isolators

5.1 Switchgear shall be of substantial construction, metal enclosed and fitted with gasketed doors.

5.2 Switches and isolators shall be of the rating specified and have facilities for padlocking in the 'OFF' position.

5.3 Protective devices shall generally conform to the requirements of protective devices under section headed low voltage switchboards.

5.4 Instructions shall be obtained for any equipment mounting heights that are not specified. All fixing materials including any necessary steelwork shall be supplied as part of the switchgear. Internal fixing holes shall be made watertight after fixing.

5.5 Where separate switchgear units are looped together and the size of cable is such that two

cores cannot be accommodated in each terminal, suitable double-entry cable sockets shall be provided. Where this is not possible the necessary adaptable boxes shall be provided. All switchgear units shall be suitably bonded and earth terminals provided.

6.0 Distribution Boards

6.1 Distribution boards shall generally be metal clad, surface mounting type with integral isolation up to 200A and fitted with MCBs of rating and type as detailed elsewhere in this specification. For flush installations the conduits shall be terminated in a recessed length of appropriately sized trunking over which the distribution board shall be mounted.

6.2 Spare ways shall be fitted with manufactured blank plates.

6.3 A separate neutral and earth connection point shall be provided for every outgoing way. Outgoing circuits shall be wired to the corresponding neutral and earth connection as the phase conductor and be identified by numbered sleeves with corresponding live, neutral and earth conductors provided with matching references.

6.4 Distribution boards where not in a locked store, cupboard or plant room shall be fitted with barrel locks capable of being opened or locked with a key common to all distribution boards. Two keys shall be supplied with each board, unless otherwise specified.

6.5 Each distribution board shall be provided with an approved label/card enclosed in a non-flammable transparent plastic envelope securely fixed to the inside of the door. The label shall show the number of each way, its reference, the rating of the MCB, the cable size and the apparatus/item connected. The ways shall be clearly identified and may be by means of a numbered plan or a printed statement to the effect that the number of ways is from left to right.

7.0 Earthing Arrangement and Protective Conductors

7.1 The installation shall have separate neutral and protective conductors throughout.

7.2 Main equipotential bonding of extraneous conductive parts shall connect the items listed below to the main earthing terminal:

1) Mains water pipes
2) Mains gas pipes
3) Rising mains for central heating and air conditioning systems
4) Other service pipes and ducting
5) Structural steelwork

7.3 Local supplementary bonding shall be carried out to connect the extraneous conductive parts of exposed metal work to maintain an equipotential zone. Typical examples are listed below for guidance purposes only:

1) Bond between the hot and cold water pipes and metallic wastes or Metal trays for basins, sink, baths and showers.

2) Bond between radiator and connecting pipework.

3) Bond from the exposed conductive parts of the electrical system in each space to the heating, water and gas pipework in that space.

4) Bond between any fixed conductive parts, exposed or extraneous, within 2m of each other unless tests show adequate continuity.

5) Bond between the main members of a suspended ceiling grid using a looped principle. Minimum frequency one bond per 50m² of ceiling or one per room.

6) In metal frame partitions bond at one point in every electrically continuous section to frame to the exposed conductive parts of any mains voltage electrical system within that partition.

7) Bond raised floors with one protective conductor per 50m². If the raised floor is not inherently electrically continuous the Contractor shall include for additional connections (looped) to provide complete bonding.

7.4 Supplementary bonding connections shall not be made to terminals inside socket outlets or spur units due to the possibility of accidental contact being made with live terminals. All earth bonding shall be made external to such fittings.

7.5 Attachment of the protective conductor to pipes shall be by means of an adjustable earth clip that shall be complete with a metal label with the legend "Safety Electrical Earth - DO NOT REMOVE".

7.6 All trunking, conduit and cable tray shall be mechanically and electrically continuous throughout their lengths and effectively bonded, where this cannot be guaranteed earth links shall be connected at each junction.

8.0 Wiring Systems

General

8.1 Wiring systems employed to serve the installations shall include the following:

i) Multicore armoured cables
ii) Cu/PVC insulated cables in conduit
iii) PVC/PVC cables
iv) MICS/PVC or LSF cables
v) PVC and rubber insulated flexible cords

8.2 As to which system is to be installed where shall be as outlined on the drawings and elsewhere in this specification.

8.3 Minimum cable size shall be 1.5mm² unless stated otherwise.

Multicore Armoured Cables

8.4 Cables shall be either PVC/SWA/LSF or XLPE/SWA/LSF as specified consisting of copper conductors and comprise full rated neutrals unless otherwise stated.

8.5 Where cable glands are employed, these shall be provided with an integral earthing connection.

8.6 Where cables cross expansion joints in structures, loops shall be formed. It shall be the Sub-

Contractor's responsibility to determine the number and position of expansion joints.

8.7 Low voltage cables direct in the ground shall be laid at a minimum depth of 550mm 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.lmm gauge, coloured yellow with the words 'Electric Cable Below' along its length.

8.8 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 x 75mm thick, be indelibly marked "Electrical Cables" and 300mm shall be exposed above ground.

8.9 The cables shall be marked at each end and at access points by a label indicating the cable size and circuit.

8.10 Cables under roads, rail crossings and hardstanding areas or within floors or walls shall be run in black twin-wall rigiduct. The ducts shall have a minimum diameter of 100mm and have slow bends to suit the cables. Ducts either side of a road, rail crossing or hard standing area shall extend by 1m either side.

8.11 Cable ducts that terminate in the 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 ducts shall be similarly sealed.

8.12 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.

8.13 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. Cleats for cables up to and including 50mm diameter shall be fixed by a single bolt and above 50mm diameter 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 PVC/XLPE 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 or where more than three cables are to be run together. Such steelwork shall be protected by a rust inhibiting paint.

8.14 All joints shall be made in cast iron or moulded plastic boxes purpose made for PVC/XLPE/SWA/PVC sheathed cables, joints being wrapped with PVC/XLPE tape to give a degree of insulation at least equal to that of the original insulation, and the boxes filled with an approved compound.

8.15 Where cables are terminated outside buildings, or in damp situations, compound filled boxes shall be used.

8.16 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.

Cu/PVC or Cu/LSF Insulated Cables in Conduit

8.17 Cables for use in conduit installations shall be stranded copper type with PVC or LSF installation and specified and of the designation 6491X/6491B.

8.18 All conduits and cables installed shall be of approved manufacture and shall comply with the appropriate British Standards.

8.19 Conduit installed shall not be smaller than 20mm diameter or greater than 38mm unless specifically indicated.

8.20 Conduit shall consist of the following types:

i) High impact unscrewed rigid PVC.
ii) Metal black enamelled Class 2 type for general internal building areas.
iii) Galvanised conduit to Class 4 for basements, plant rooms, ducts and exposed or external positions.

8.21 Where galvanised conduit is used all screwed joints must be water tight by means of suitable metallic paint.

8.22 Metal conduit shall be tested for satisfactory electrical continuity before plastering or screeding and before cables are drawn in.

Manufactured tees, bends and elbows shall not be used.

8.23 Installation of conduits within floor slabs or screeds shall not be permitted unless authorised by the Engineer. The type of conduit in such instances shall be of the galvanised type.

8.24 Conduits crossing expansion joints shall be fitted with 300mm of flexible conduit terminating at each end in conduit adaptors. All such joints shall be identified and appropriate action taken.

8.25 Conduit expansion joints shall be fitted at the intervals recommended by the manufacturer.

8.26 Conduit sets through walls will not be permitted. When change of direction is required after passing through a wall, an appropriate back outlet box shall be fitted.

8.27 Conduits installed shall be of sufficient capacity to allow the cables to be easily drawn in and out.

8.28 Conduits with a badly formed or damaged thread shall not be used.

8.29 Tallow shall be used as a cutting lubricant for steel conduits.

8.30 Burrs and sharp edges shall be removed by a purpose made tool after threading, leaving a smooth, countersunk end. Dirt, paint and oil shall be removed from screw threads before fixing. All exposed threads and vice marks shall be coated with "Drygalv" zinc-rich paint immediately after fixing.

8.31 Drawings shall be submitted showing the proposed conduit runs, including the positions of draw-in boxes.

8.32 Where the finish of the conduit is damaged during installation the affected portions shall be protected with a coat of bitumastic paint immediately following installation. For concealed conduits sufficient time shall be allowed for the paint to dry before the conduit is concealed.

8.33 Bending and jointing of PVC conduit shall be in accordance with the manufacturers recommendations.

8.34 At all lighting support points the conduit boxes shall be fitted with steel support inserts fixed to the structure to support ceiling mounted luminaires.

8.35 PVC conduit shall be of the Super High Impact type and shall only be installed when the ambient temperature is between 5°C and 35°C.

Cables

8.36 Insulated and sheathed cables shall be of insulated and sheathed type with or without CPC and of the general cable references 6242Y. Cables shall be insulated and sheathed with either PVC or LSF as specified.

8.37 Where cables are routed through floor voids containing timber joists the cables shall run either at right angels to or parallel to joists. Holes required for routing at right angles shall be located not less than 50mm from the top of the joist. For cables running parallel to joists moulded clip fixings shall be installed at not less than 50mm from top or bottom of joists; slotting of joists shall not be permitted.

8.38 Cables dropping vertically within plastered or partition walls or where there is a likelihood of mechanical damage shall be protected by either:

i) Oval plastic conduit fitted to the gap entry box or terminating 10mm within the box.
ii) Galvanised steel channel.
iii) By use of 20mm PVC conduit with outlet box at the required height. The conduit shall be fitted with ring bush at point of cable entry.

8.39 Cables passing through walls shall be protected by steel conduit extending minimum 50mm clear of the sides and fitted with a brass ring bush at each end.

8.40 Cable entries into metal boxes shall be protected by means of rubber grommets or grommet strip.

8.41 At building expansion joints, cable loops shall be provided.

8.42 Multiple runs of six or more cables shall be fixed to appropriately sized galvanised cable trays in buildings other than domestic dwelling houses.

8.43 In ceiling spaces greater than 300mm deep, cables shall be supported by approved hangers. Multi-cable runs shall be bunched in groups of six.

8.44 For ceiling spaces less than 300mm deep or where a ceiling is fixed directly onto battens, the cables shall be fixed to the structural ceiling.

8.45 Cables concealed in concrete floors shall be protected through 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.

8.46 Joint and junction boxes shall not be permitted in hidden or inaccessible positions and those in damp situations shall be moisture-proof and fitted 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.

8.47 At each lighting point the cable shall be terminated within a circular steel or PVC box with cable clamps and the box securely fixed 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 at every point.

8.48 All metalwork such as switch boxes, channels, conduits, conduit boxes and metal light fittings shall be properly bonded to earth.

Mineral Insulated Copper Sheathed Cable (MICS)

8.49 MICS cables shall consist of copper conductors; copper sheathed and PVC or LSF insulation.

8.50 Light duty (600 volts) grade shall be utilised for single-phase circuits, fire alarm systems, call systems and where otherwise specified.

8.51 Heavy duty (1000 volts) grade shall be utilised for three phase circuits.

8.52 Cabling shall be installed using tools recommended by the manufacturer and arranged neatly and unobtrusively cables shall be installed parallel to general building lines where run on the surface of walls or ceilings.

8.53 Cables shall be protected by plastic or fibre sleeves where passing through walls or crossing ducts and trenches.

8.54 No cables shall be installed in floors unless authorised by the Engineer. In such an instance occurring the cables shall be protected within PVC ducts.

8.55 Terminating glands on cables shall be of the universal ring type and seals of the screw-on pattern.

8.56 Earth tail pots shall be used on all but extra-low voltage circuits.

8.57 Seal caps, compound and conductor sleeving shall be supplied appropriate to the operating temperatures to be encountered.

8.58 All tails shall be of sufficient length for remaking broken connections.

8.59 Where cables cross structural expansion joints, loops shall be formed in the cables.

8.60 Cables shall be looped one complete turn where connections are made to motors and other equipment where vibration is likely to occur.

8.61 Cables shall be secured by means of one-hole clips where only one cable is installed. For several cables together multi-way saddles shall be used in accordance with the manufacturer's recommendations. Brass screws shall be used for the fixing of such saddles.

8.62 Where two or more cables run along a common route in plant rooms, roof and floor spaces, ducts, crawlways, etc., such cables shall be mounted on cable tray.

8.63 Cables shall be terminated in gasketted-galvanised boxes in damp situations.

8.64 Where two or more single core cables are used for power distribution the terminations shall be via brass gland plates.

8.65 The PVC sheath colours to MICS cables shall be selected as follows:

Orange	-	For all power distribution cabling
Red	-	For fire alarm installations
White	-	For extra low voltage circuits

PVC and Rubber Insulated Cables and Flexible Cords

8.66 The type of insulation, number of cores, size of conductors and sheathing shall be as specified in the schedules or shown on the drawings.

8.67 Unarmoured P.V.C. and rubber-insulated cables shall be protected by conduit or trunking.

8.68 Conductors shall not be wrapped around 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.

8.69 Flexible cords shall be of the 300/500-volt grade, the type of insulation being suitable for the working temperature.

9.0 Trunking Installations

9.1 Trunking shall be supplied in standard lengths, each length including a coupling sleeve, and be free from all sharp edges and projections.

9.2 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.

9.3 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.

9.4 Vertical trunking shall be fixed to the building structure at intervals of 1.2m or as specified in the schedules or drawings.

9.5 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.

9.6 No suspensions or fixings shall intrude into the internal space unless otherwise specified.

9.7 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.

9.8 Manufacturers standard fittings shall be used. Only in exceptional circumstances 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.

9.10 All trunking shall be provided with internal fire barriers where they pass through fire resisting structure. Internal fire barrier shall be made by binding the cables and filling the spaces with suitable fire resistant material.

9.11 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.

9.12 In vertical runs, cable support pins shall be fitted at intervals not exceeding 5m.

9.13 In horizontal runs, cable retaining straps or holders shall be provided at intervals of not more than 1m, where the lid is on the underside of the trunking.

9.14 Trunking shall terminate with end flanges, which shall be bolted direct to fuseboards or apparatus.

9.15 At constructional expansion joints the trunking shall be provided with a sliding coupling complete with flexible earth continuity tape.

9.16 Where conduits are connected to multi-compartment trunking, access to the appropriate compartment shall be gained via conduit end boxes adjacent to the appropriate compartment.

9.17 Trunking and connectors shall be Class 2 finish unless otherwise specified.

9.18 A copper earth-bonding link by the trunking manufacturer shall be fitted to the outside between adjacent lengths of trunking and fittings supplied by the trunking manufacturer. These links are to be relied upon for earth continuity and must be of a size to comply with BS7671.

9.19 Steel thicknesses shall be at least 1.0mm for 50mm x 50mm trunking, 1.2mm for trunking between 50mm x 50mm and 150mm x 150mm and 1.6mm for trunking of 150mm x 150mm and above.

9.20 Where two or more services required to be segregated are installed in a common trunking, this shall be by earthed steel partitions.

9.21 Trunking shall not be used on an outdoor installation; unless the trunking and accessories are gasketed and 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.

9.22 PVC 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 standard green/yellow insulated copper earth wire or bare copper tape conforming to BS7671shall be run throughout the whole length of each trunking as the protective conductor.

9.23 Where floor trunking is to be utilized, it shall be of the type specified and the positions of runs, junction boxes and outlets shall be as shown on the drawings. Where raised floors are to be provided, multi compartment floor boxes shall be installed of the type specified the floor boxes should be connected to the trunking by means of an appropriate number (ie. 3 in the case of three compartment trunking and floor boxes) of metal flexible conduits 3m in length (one between each compartment).

9.24 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.

9.25 Skirting trunking runs and positions of outlets shall be as shown on the drawings where two or more services require to be segregated to be installed, each service shall be run in a separate compartment in a common trunking.

9.26 Removable telephone or data plates shall not expose live terminals or if common plates are used the terminal of main socket outlets shall be shrouded.

9.27 Lighting trunking shall be as specified and the position of runs and luminaires shall be as shown on the drawings.

9.28 Trunking routes shown on the drawing are indicative, assess the optimum trunking route during the tender period and allow for the required sets, bonds tees etc to achieve a neat and tidy installation.

10.0 Cable Tray Installations

10.1 Cable tray metal thickness shall not be less than 0.9mm up to 100mm width, 1.25mm widths between 100mm and 150mm and 1.6mm for widths between 150mm and 300mm.

10.2 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 P.V.C. coated.

10.3 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.

10.4 Fixings to the 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 the 1.2m and at 225mm from bends and intersections.

10.5 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.

10.6 Manufacturers bends and intersections shall be used and when sections are cut, all sharp edges shall be removed and exposed metalwork painted with rush inhibiting paint. Holes through tray shall be similarly treated and suitably bushed.

10.7 Cables shall be fixed by proprietary saddles or clips as specified.

10.8 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, definite earthing connection to the tray shall be made.

10.9 Where cable tray is to be installed as the cable routing medium beneath a raised floor the Contractor shall install a 3m length of metal flexible conduit between each compartment of the floor outlet box and the appropriate tray. This shall apply regardless of whether the cable installation to all compartments forms part of this installation.

11.0 Lighting Installation

11.1 All luminaires listed in the lighting schedules shall comply with the appropriate British Standard and be supplied and installed complete with new lamps and cleaned at the time of handover.

11.2 All fluorescent luminaires shall be provided with high frequency electronic control gear and shall be internally fused.

11.3 Diffusers where specified for fluorescent luminaires shall be of the acrylic type.

11.4 For luminaires installed within accessible ceiling voids, final connection will be carried out via a plug-in ceiling rose and 1.5m (maximum) length of heat resisting flexible cord.

11.5 For luminaires installed within inaccessible ceiling voids, the outlet box shall be supported off the structure and positioned so as to be accessible for re-wiring (loop-in system).

11.6 Where luminaires are to be suspended from trunking (in industrial locations) manufactured stirrup brackets shall be used which clamp around the trunking. Additional trunking suspensions shall be installed to support the additional luminaire weight. Connections to the luminaire shall be by plug and socket arrangement of capacity and rating adequate for luminaire to be fed.

11.7 Where different phases are shown at a common switch gang assembly phase barriers and appropriate warning labelling shall be provided.

11.8 Control gear for fluorescent lamps should be such that the noise level emitted must not exceed 36dbA (NR 30) when obtained from the average of sound pressure levels each measured 1.0m from the control gear in at least five positions on each side and below the luminaire.

11.9 Linear fluorescent tubes shall generally be of the T5 type unless otherwise specified.

11.10 Where discharge lighting luminaires are to be installed the associated control gear shall be integral unless otherwise specified.

11.11 Lighting switches installed externally shall be of the weatherproof type and rated to IP54; sited where possible in sheltered locations.

11,12 Through wiring will not be permitted in any instance without authorization from the Supervising Officer.

12.0 Emergency Lighting Installation

12.1 Emergency lighting luminaires shall be supplied and installed as detailed on the drawings and in the luminaire schedules.

12.2 Provide for each emergency luminaire or group of emergency luminaires on a circuit a secret key "grid-switch" arranged as follows:

i) With the key switch in its normal position, permanent live to the emergency luminaire is on.

ii) With the key switch in the test position, the permanent live supply to the emergency luminaire is off. In this situation the luminaire will be functioning under emergency mode only.

12.3 Switch combination switches must be engraved with "EMY. LTG. TEST".

12.4 Switches shall be arranged to test the luminaires on a circuit basis for large areas or room basis for smaller areas. The test switches shall be sited so that the luminaires under test can be observed from the switching position.

12.5 The duration of the emergency battery supply shall be 3 hours irrespective of the type of system selected, i.e. maintained, non-maintained or sustained.

12.6 On completion of the installation, or part thereof, the completion of appropriate inspection and test documentation shall be required. The engineer shall be advised at least ten clear working days before the tests are to be undertaken so as to enable the various authorities to witness the tests.

13.0 External Lighting Installation

General

13.1 External lighting shall be provided as detailed on the drawings and on the schedules.

13.2 Where indicated, install local isolation fireman's switches to control external lighting.

13.3 The installation shall be controlled using a time switch/photocell and contactor arrangement. Time switches where indicated for the use on external lighting shall be of the quartz type with battery back up. Time switches shall be of the solar dial type, appropriate for the location of the premises and be complete with two "on" and two "off" tappings.

Street Lighting Installations

13.4 Unless otherwise specified, the Main Contractor will be responsible for excavation erection of

the columns concreting and backfilling, and the correct alignment of the columns.

13.5 Holes shall be excavated to the appropriate planting depth. Root depths, where the ground is consolidated and where no underground obstructions require the use of raft or crank roots, shall comply with the manufacturers recommendations with a minimum depth of 900mm. In normal well-consolidated soil, the lighting column shall be set on a minimum 75mm deep x 500mm dia concrete ST4 base within a vertical tube (concrete, clayware, plastic) itself surrounded in ST5 grade concrete minimum 200mm thick carried up to underside of footway subbase. The annular space between the tube and the lighting column shall be filled with compacted sand. A 50mm diameter duct for cable access shall be installed through the concrete and sand, into the cable entry of the lighting column base. The upper surface of the sand surround should be capped with minimum 75mm deep concrete grade ST5 (to protect the sand).

13.6 Prior to erection, the excavation shall be cleared of obstructions, water, rubble or loose soil. Any bare or corroded patches of steel column roots shall be cleaned and treated with bituminous paint. Base plates, where provided, shall be fitted securely and when used for earthing shall be bonded to the column. Base stones or pads shall be placed in position, where appropriate. Columns shall be correctly aligned in the vertical position with door openings facing away from the oncoming traffic, unless otherwise specified.

13.7 Columns shall be erected prior to cabling and the earth surrounding them shall not be disturbed for at least seven days.

13.8 Cables serving standards must loop into and out of the standards, except where otherwise stated.

13.9 The cables shall follow the route shown on the drawings and, unless otherwise detailed shall be laid direct in the ground 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 long its length.

13.10 Wiring between the cutout, lantern and control switch, if not specified, shall be 2.5mm² PVC insulated and sheathed.

13.11 Control switches shall be of the weatherproof rotary type, all wiring being inside the column.

13.12 A control gear compartment shall be provided in all columns, to contain the specified cut-outs and the cable sealing chambers complete with armour clamps.

13.13 Access to the compartment shall be by means of large weatherproof door with locking device to resist unauthorised entry.

13.14 A baseboard for the control gear shall be fitted inside the compartment. The baseboard shall be manufactured from a material that is non-hygroscopic.

13.15 The exterior of the column and any metal attachment shall be painted after erection in accordance with the specification.

14.0 Small Power Installation

14.1 All sockets shall be of the shuttered type.

14.2 Socket outlets rated at 13A shall generally be wired on a ring circuit unless otherwise specified. The midpoint accessory must be identified and its plate engraved for purposes of testing.

14.3 Where socket outlets are to be controlled by master switches, 20A double pole switches with neon indicators shall be employed. Such circuits shall generally be wired on a radial basis from the master switch.

14.4 Items of equipment served by radial or ring circuits less than 3 kW shall be connected via a local switched fused connection unit unless otherwise stated.

14.5 Hand drier connections shall be made flush throughout with a local isolation via a high level mounted 13Amp fused connection unit with appropriately sized fuse. The outlet shall be unswitched. The hand drier units shall be mounted over a circular outlet box flush with the wall finish. Final connections between the fused connection unit and the hand drier shall be made in 1.5mm5 three core heat resistant flex.

14.6 Ensure that all plug tops are fitted with appropriately sized fuses, rated to the appliance load. Where not supplied as part of an appliance provide as necessary.

15.0 Accessories

15.1 All accessories on the project shall be as manufactured by one manufacturer unless otherwise specified. Accessories shall be either flush or surface, dependant on installation type and be fitted with appropriate metal boxes.

15.2 Light switches shall be of 20Amp rating, constructed from modularised components, and shall be of the rocker type with multi gang switch toggles labelled to indicate duty.

15.3 All fuse connection units shall have neon indicators.

16.0 Fire Alarm Installation

16.1 The fire detection and alarm system shall utilise manual call points and automatic detectors as detailed on the drawings.

16.2 All components and their performance shall comply with the relevant British Standards.

16.3 Detectors shall include a light emitting diode mounted in the side of the units. The LED will activate when that detector is in alarm condition.

16.4 Except where otherwise stated the fire alarm installation shall be a closed circuit monitored type with end of line diodes/resistors; the locations of which shall be indicated on the record drawings.

16.5 Separate radial circuits are to be employed for the wiring of sounders and detectors/break glass units. No tee-off's shall be permitted.

16.6 Where electrically operated door holders are installed these shall be designed to release the doors in the event of a fire alarm. Door holders shall be of the fail-safe type.

16.7 Wiring serving the fire alarm system shall consist of light duty MICS/PVC (red) with 1.5mm² conductors for detector/break glass circuits and 2.5mm² for sounder/bell circuits.

16.8 Any component located externally shall be of the weatherproof type.

17.0 Lightning Protection System

17.1 Where required the installation shall comply with Standard EN62305 and BSEN 62305 and consist of copper conductors except where otherwise stated.

17.2 The lightning protection system shall generally be as indicated on the drawings.

17.3 The installation shall be bonded to the building power earthing system.

17.4 All metallic projections or equipment at the rooftop shall be bonded to the air termination network.

17.5 Earth electrodes shall be of solid drawn high conductivity copper rods with steel cores.

17.6 Final connection to the earth rod will be facilitated by use of copper strip routed within 50mm diameter PVC duct from just above ground level to the earth pit.

17.7 The lightning conductor system shall be bonded to the main earthing terminal of the building.

18.0 Mechanical Services Attendances

18.1 Supply and install all cabling associated with the Mechanical Services' attendance as indicated on the drawings.

18.2 Where extract fans with controllers are indicated a separate circuit shall be used to serve a single or group of fans. The extract fan unit will be supplied and installed by others. The controller shall be installed although supplied by others.

19.0 Communications and Data Outlet Wiring

19.1 Supply and install specified cable routing/containment from the location of the main telephone equipment to the locations shown on the drawings.

19.2 Where multi-compartment trunking is specified then a dedicated compartment shall be used for routing of communications and/or data cabling. The link between the trunking and both the main telephone equipment and the particular telephone point shall be achieved using 25mm diameter PVC conduit terminating in an adaptable/outlet box as appropriate.

19.3 Install draw wires within the telephone and data conduits to allow installation of cabling where it is to be installed by others.

20.0 Testing and Commissioning

20.1 The scope and standard shall be as prescribed by the appropriate Regulations.

20.2 Initial testing shall be carried out together with all verification works, submit recorded test data to the Engineer for his inspection at least one week prior to arranging the witnessing or proving of test values.

20.3 Test values must be satisfactory before the Engineer is requested to witness results. The witnessing period shall not be considered as further opportunity of rectification works, which shall have been carried out earlier.

20.4 The proper operation of every part of the installation including all control devices and time switches shall be demonstrated. The procedure shall include a visual inspection of the installation.

20.5 Any control/electronic components, which could be susceptible to damage during testing procedures, shall be isolated.

20.6 All instruments required for testing shall be provided. Such instruments shall be correctly calibrated and proof of certification, by an approved authority, shall be forwarded to the Engineer for inspection.

21.0 Mounting Heights and Locations of Equipment

21.1 The following items of wall mounted accessories and equipment shall generally be installed at heights stated below unless specifically required otherwise by DDA, Building Regulations Part M requirements or Employers requirements:-

Equipment	**Height of Centreline Above FFL (mm)**
Lighting Switches General	1200
Lighting Switches Disabled Toilets	1000
Socket Outlets General	400
Socket Outlets Over Worktops	300 Above Worktop
Fused Connection Units	Adjacent to equipment being served
Cable Outlet Plates	Below worktops, 300 otherwise adjacent to equipment being served
Call Pushes Disabled Toilets	1000
Voice/Data Outlet Points	450
Fire Alarm Call Points	1200
Wall Mounted Panels	1400

Emergency Stop Pushes	1600
Conventional Fire Alarm Sounders	1900
Flashing Indicator Lights	1900
Light and control switches	1200
Sockets and fused connection units	450
Sockets cooker outlets sockets and fuse connection units above worktops	150 above worktop
Breakglass contacts	1200
Fire Alarm Sounders/Flashing Lights	1900
Alarm Panels	1400
Fireman's switches (external)	2800
Hand Dryers	1200
Distribution Boards	1600
Emergency Stop Pushes	1600

The exact positions shall be agreed where appropriate, prior to installation of equipment.

21.2 The height and position of outlets of fixed items of equipment shall be positioned adjacent to the equipment entry point, thus keeping the length of final connections to a minimum.

21.3 The Contractor shall ensure that all accessories are installed in line with each other both vertically and horizontally to give a neat and symmetrical layout. The Contractor shall be responsible for re-siting where necessary items which do not comply wit the requirement, at his own expense, including all necessary making good, redecorating and any consequential delays.

22.0 Labelling

22.1 Switch panels and distribution boards containing equipment operating in excess of 240 volts shall be fitted with an engraved label with the words "DANGER" in white/red/white and shall have the operating voltage indicated. All terminal blocks and/or strips shall be correctly identified to indicate the equipment to which they are connected. All labels shall be attached by means of bolts and nuts.

22.2 Labelling shall be provided at all items of equipment, switchgear and circuits. For switchgear, labels engraved with 5mm red letters identifying the equipment reference and the items generally served shall be fixed using setscrews and nuts. Under no circumstance shall adhesives or self-tapping be used.

22.3 Each distribution board shall be identified by an externally fitted approved label that shall be

inscribed with the following details:

i) Distribution board reference number
ii) Size of feeder cable serving distribution board
iii) Location and origin of feeder cable
iv) Earth fault loop impedance per phase
v) Live to neutral (short circuit) impendence per phase (will be equal per phase)

The exact legend shall be agreed with the Engineer prior to ordering.

22.4 For cables the Sub Contractor shall ensure that all sub mains cables are identified at both ends by means of engraved labels indicating the following:

i) Number of cores
ii) Phase colour
iii) Size of cable
iv) Origin and destination, e.g. main panel (ref) to DB4

22.5 Final circuit wiring shall be identified using ferrules sleeves at the D.B.

23.0 Painting

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

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

23.3 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 plum bate primer containing not less than 73% of calcium plum bate in the pigment, and finished as detailed below. The pigment binder ration shall not be less than 2/1.

23.4 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.

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

23.6 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. 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 or red oxide.

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

23.8 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.

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

23.10 All engineering equipment shall be sealed against entry of damp atmosphere before despatch from the markers 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.

23.11 All painting shall be carried out by skilled tradesmen.

23.12 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 galvanised surface is removed, the area shall be painted with zinc rich primer before any rusting commences.

23.13 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.

23.14 The backs of frames, brackets etc. 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.

23.15 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.

23.16 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.

23.17 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.

23.18 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:

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

23.20 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 etc. filled with hard stoppings. Oil and grease shall be removed with clean white spirit or naptha.

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

23.22 Primary costs shall be as follows:

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

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

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

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

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

24.0 Bacteria Free Materials

24.1 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.

25.0 Interference Suppression

25.1 All equipment used for the erection of the works shall, where necessary, be fitted with suppressors to limit radio interference to the levels prescribed.

26.0 Foundation Bolts and Alignment

26.1 Foundation bolts of the correct diameter and length of the straight shank type, 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, shall be supplied for each item of equipment fixed to a concrete floor or base. 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.

27.0 Connections to Vibrating and Moveable Equipment

27.1 Conduits to all motors, withdrawable or removable items of equipment and all items of equipment where vibration may reasonably be expected, shall be flexible of the P.V.C. sheathed type. The ends of the flexible conduit shall be connected to the fixed conduit system by means of adaptors fitted with an external lug for earthing purposes. Electrical continuity shall be maintained by running outside the conduit a separate earth wire of minimum size 4mm^5 with green/yellow P.V.C. sheath securely fastened at each end and securely clipped to the conduit at close spacing along the full length of the conduit or wrapped around the conduit.

OPTIONS

28.0 Air Circuit Breakers

28.1 Air circuit breakers shall be of the 4 pole withdrawable pattern. They shall be self-aligning and connected to the busbar via a plug and socket arrangement, when withdrawn safety shutters shall be provided which will automatically cover both sets of busbar i.e. feeder and circuit. Each set of busbar shutters shall be capable of being operated individually.

28.2 In the case of bus section switches both sets of shutters shall be red with appropriate warning labels and indication provided to show clearly which set of busbars each set of shutter protects e.g. an arrow pointing in the direction the busbar extends.

28.3 Generally air circuit breakers shall be automatic with the exception of bus couplers, which shall be manually operated. Circuit breakers shall be capable of being interlocked, as shown on the drawings with a castell key type device and in the case of automatic circuit breakers additional mechanical interlocks shall be provided in the form of mechanical linkage or bowden cable, the former being preferred.

28.4 The closing mechanism shall be by stored energy spring both manually or electric motor (a. c.). A visual mechanical indicating device shall clearly identify the circuit breaker state (open or closed).

28.5 Each circuit breaker shall be able to be locked in the "off" position. Each circuit breaker shall have trip free operating mechanisms and the following tripping devices.

28.6 Automatic breakers only - electric trip device (30V shunt trip) operated by equipment specified elsewhere.

28.7 The shunt trip device shall continue to operate at 50% reduction in operating voltage.

28.8 In addition, breakers shall be provided with the following as required.

i) Anti-pumping device.
ii) Cut throat trip contact (early make contact in trip circuit)
iii) Control switch - remote/local
iv) Control switch - trip/close
v) Sufficient carriage switches to enable circuit breaker withdrawal
vi) Sufficient auxiliary contact to provide interlocking and status signals as required.

28.9 Air circuit breakers shall be capable of withstanding the system short circuit fault level at its point of installation.

29.0 Power Factor Correction Equipment

29.1 The whole of the power factor correction installation shall be suitable for continuous operation.

29.2 The equipment design shall be such that the maximum use is made of common parts supplied by the same manufacturer.

29.3 All power factor correction equipment shall be designed for operation from a nominal 415/240V

3 phase 4-wire 50 kHz a.c. supply system and shall be capable of tolerating the voltage and frequency variations permitted by statute.

29.4 Capacitors shall be of the metalized polypropylene film type, having the individual elements either encapsulated in epoxy resin or immersed in an approved dielectric fluid.

29.5 All containers shall be hermetically sealed.

29.6 Each capacitor shall be provided with a rating plate giving details specified on the schedule.

29.7 The number and capacitance of the capacitor units incorporated in each correction equipment shall be such that the capacitance can be switched into and out of circuit in steps of the numbers and magnitude specified.

29.8 The required number of capacitor units shall be accommodated in a suitable cabinet or a series of modular cubicles assembled together to form a composite unit.

29.9 Each assembly shall be complete with incoming isolating switch of appropriate rating, HRC fuses, the fuse rating of which shall not exceed 1.5 times the rated capacitor current, a set of insulated copper busbars rated for the total capacitive load, suitably rated contactors for the automatic switching of the capacitors in stages and a suitable control relay of approved design.

29.10 Connection links shall be provided to permit easy removal or re-location of units, and provision shall be made for extension at one or both ends of the busbar system.

30.0 Standby Generator Supplies

30.1 The whole of the generator assembly shall be statically and dynamically balanced during manufacture and as a composite unit.

30.2 All external electrical and mechanical connections to the unit shall be of an approved flexible type to permit free movement of the set on its resilient mountings.

30.3 A flexible coupling shall be provided between the engine and generator to prevent transmission shock loads. The torsional flexibility shall be designed to match the torsional characteristic of the system to prevent resonant conditions.

30.4 A permanent warning notice of approved type and size, having a durable transparent finish to its surface, shall be provided and fixed in a conspicuous position on the engine generator unit. The notice shall bear the following wording in 13mm high red letters on a white background.

"THIS SET IS REMOTELY CONTROLLED AND MAY START AT ANYTIME. WRITTEN AUTHORITY MUST BE OBTAINED AND APPROPRIATE SAFETY PRECAUTIONS TAKEN BEFORE ANY WORK IS UNDERTAKEN ON THE SET OR ASSOCIATED CONTROL EQUIPMENT".

30.5 A complete set of tools shall be provided, including grease and oil guns, necessary for the normal maintenance of the set and its controls. The tools shall be of the best quality, the spanners being of chrome-vanadium steel, and shall be contained in a suitable robust steel toolbox with lid fitted with a substantial clasp and lock. The lock shall be provided with two keys.

30.6 Wall charts and notices shall be mounted on stiff damp-proof material and have a durable

transparent finish to their surfaces, enabling them to be cleaned repeatedly without damage.

30.7 An initial supply of fuel oil and of all lubricating oils and greases shall be provided. The quantities provided shall be such that there is sufficient remaining after the completion of testing and commissioning to provide, at least, twenty four hours running on full load.

30.8 Additional lubricating oil shall be provided for re-charging the engine sump once, together with a supply of lubricating oils and greases to cover the normal use and servicing of the set during the twelve months maintenance period referred to below.

30.9 The complete unit and its ancillaries shall be tested as a composite unit at the manufacturers works (or elsewhere by agreement) for output and performance. Adequate notice in writing of the date and time of the works and test shall be given.

30.10 The noise level from the engine and generator set when operating under full load conditions, obtained from the average of sound pressure levels, each measured at 2m from the set in at least five positions on each side and above shall not exceed 90 dB Scale 'A' (noise rating number 84). Readings of more than 10 dB below the maximum readings shall be disregarded.

30.11 If the set is to be synchronised with either an existing or a future set, the governor shall be modified to facilitate such synchronising.

30.12 Engines shall be of the vertical multi-cylinder four-stroke diesel type, designed and constructed as a static land based machine, suitable for continuous running on engine fuel. The engine shall be fitted with over speed protection and speed governing. Governors for sets of 300BHP and over shall be of the Woodward type.

30.13 Engine starting shall be by means of a battery driven electric starter, motor complete with automatic starting and sequencing control equipment and starter isolating switch or sequence cut out switch. The mains operated battery charger shall be disconnected during the start sequence. A starting handle or barring gear shall be provided.

30.14 The automatic start sequence shall include a 'crank limiting' device to disconnect the starting motor if the engine fails to start in approximately eight seconds. Two further attempts shall be made to start the engine with an interval between the attempts of three seconds. If the engine fails to start after three attempts the system shall be shut down and the warning devices actuated.

30.15 Sets with outputs of more than 250kVA and at least six cylinders shall preferably be arranged for air starting with separate compressor and storage vessel.

30.16 Engine safeguards shall be provided to shutdown the engine and provide individual and audible alarms for the following conditions:

Engine over speed

High cooling water temperature

Low lubricating oil pressure

With the exception of over speed it shall be possible to over-ride these safeguards and run the engine manually.

30.17 The starter battery, which shall be a heavy duty high performance type mounted in a suitable box, shall be 12 volts (for sets up to 50kVA) and 24 volts (for sets of 50kVA and above). Means of battery charging shall be provided, this being either a mains driven battery charger with both trickle and boost charge settings, automatically controlled, or a mains driven trickle charger and a set of driven dynamp. Suitable ammeters and voltmeters shall be provided to a monitor both battery charge rates and battery volts.

30.18 The following instruments shall be provided either mounted on a suitable panel fixed to the engine or incorporated on the main control panel.

Engine shaft speed indicator reading in r.p.m.

Service hours counter

Lubricating oil pressure indicator

Lubricating oil temperature indicator

Cooling water temperature indicator

30.19 Sets of up to 35kw output may be air cooled, except where noise considerations make this impractical. Sets above 35kw output shall be water cooled, the cooling water temperature not exceeding 85 degrees C. For sets up to 1120kw, except where otherwise specified, water circulation shall be by means of a gear or shaft driven pump through a suitably designed radiator, with an engine driven fan for the cooling air supply. Thermostatically controlled electric immersion heater(s) of an approved type and suitable for mains operation shall be installed and connected into the cooling water circuit. The heater(s) shall be controlled by an on/off switch with "on" indicator light mounted on the main panel and shall be capable of maintaining an effective cooling water temperature of 10°C against an ambient temperature of O°C. An inhibitor shall be added to the cooling water to protect the cooling system from internal corrosion.

30.20 Cooling water treatment shall be provided to guard against corrosion and frost.

30.21 If a radiator is fitted it shall have flanges to facilitate the connection of ventilation ducting with an airtight joint. Where ductwork is to be fitted, details and routes shall be shown on the drawings and the capacity of the cooling air supply fan shall take into account the additional resistance of the ductwork.

30.22 The lubricating oil temperature shall not exceed 100°C. Oil coolers shall be fitted with a viscosity by-pass valve set to operate at about 10% above normal operating pressure to aid cold starting. A suitable and efficient oil filter with easily replaceable elements shall be provided on the lubricating oil lines.

30.23 The exhaust system shall be manufactured in heavy quality steel tubing. Bends in the exhaust system shall have a mean radius of not less than four times the pipe diameter. A robust gas tight flexible section shall be included in the system adjacent to the engine. Where the exhaust system passes through a hole in the building fabric, the gap between the fabric and the pipe shall be packed with close laid carbon fibre (ceramic fibre) rope. A drain cock shall be fitted at the lowest point in the system suitable for draining off any condensation that may have accumulated. The cock shall be constructed of suitable material to resist corrosion.

30.24 The exhaust silencer shall be of the "straight through" absorption type. One or more suitably rated units shall be installed to comply with the noise criteria specified elsewhere. The exhaust system shall be designed so as to reduce noise to the minimum practical level without appreciably impairing the working efficiency of the engine.

30.25 The system shall be adequately supported and so designed as to clear all obstructions and facilitate maintenance. Where it is possible for personnel to come in contact with the exhaust system, suitable insulation shall be applied to the pipe or suitable protection be provided round it.

30.26 Except where otherwise stated, the generator shall be a continuously rated three phase four wire star connected alternator of the screen protected, rotating field self-exited type directly coupled to the diesel engine, the whole being designed and constructed to operate as one unit. The star point of the winding shall be earthed. Unless otherwise stated the generator may be one of the following types:

Up to 10kW rated output:

Rotating armature pattern with inherent voltage regulation. The generator may be used as the starting motor.

Between 10-20kW rated output:

Rotating armature pattern with automatic voltage regulator, no carbon stack.

Above 20kW rated output:

Rotating field pattern with overhung exciter, and external automatic voltage regulator.

30.27 The output voltage of the generator shall be automatically maintained within 2.5% of the normal or specified voltage under all conditions of load, power factor and temperature, including cold to hot variation. Additional provision shall be made for manually adjusting the output voltage within plus or minus 5%. The line voltage waveform shall be continuous wave shape to meet the requirements of rotating electrical machines.

30.28 Windings shall be impregnated with moisture, oil and acid resisting varnish and finally treated with anti-tracking varnish. Class "H" insulation shall be employed throughout. An anti-condensation heater shall be fitted.

30.29 Terminals shall be of robust construction, adequate in size for the maximum current to be carried and securely mounted with adequate mechanical and electrical protection.

30.30 The main control panel shall comprise a totally enclosed metal clad wall or floor mounted cabinet of ample dimensions to accommodate the necessary switchgear, relays and other equipment to form a complete automatic control unit for the standby set.

30.31 The cabinet panels shall be of heavy gauge sheet metal with approved anti-corrosion finish, mounted on a substantial metal framework with the panel edges recessed to present smooth face. The corners of the framework shall be rounded and smooth and all panels shall be removable to facilitate maintenance. Demountable plates of adequate dimensions and weight shall be provided for conduit or cable access to the panel. Fixing screws and studs shall be

fitted into properly tapped holes or hank bushes - self-tapping screws or spring devices shall not be used.

30.32 External access doors shall each be fitted with an interlock to prevent the doors being opened with the electricity supply on. The doors shall have handles and locks being of the same pattern throughout and operable by the same key. Duplicate keys shall be provided.

30.33 The control panel shall be complete with all necessary equipment for the manual and automatic operation of the diesel generator set. Mains sensing relays shall have an adjustable voltage setting and be designed to operate on the occurrence of a stained low voltage or loss of voltage on any one or more phases of the supply.

30.34 On operation of the diesel generator set either manually or automatically, the switching shall be such that there is no possibility of back feeding the public supply.

30.35 For sets below 500kW the control panel shall contain mechanically and electrically interlocked four pole contactors for mains/generator changeover duty, complete with voltage sensing relays and adjustable time delay devices for automatic operation on mains failure and mains restoration.

30.36 For sets of 500kW and above the mains/generator changeover shall be arranged using the main circuit breakers.

30.37 A suitable auxiliary contactor and relay shall be provided for connecting the battery charger to the mains supply, the engine is being started and reconnected when either the engine starts or when the full output voltage is established from the generator, if no other means of "boost" is provided.

30.38 Adjustable overload protection shall be provided for the generator.

30.39 The following shall be mounted on the front of the panel, all items being suitably labelled.

Low voltage indicator lamps for:

Mains supply available	Green lens
Battery charger on	Green lens
Cooling Water Heater(s) on	Green lens
Fuel on	Green lens
Fail to start	Green lens
Engine over speed	Amber lens
High cooling water temperature	Amber lens
Low lubricating oil pressure	Amber lens
Low cooling water level	Amber lens
Generator output failure (set running)	Amber lens
Engine switched off	Red lens

Three position automatic/off/manual selector.

With the selector in the "off" position, the "engine" switched "off" warning lamp shall be illuminated and it shall not be possible to start the engine in any way whatsoever.

Push button for:

Start engine, operable when the control selector is in the "manual" position.

Stop engine

Mains failure simulation

Instrumentation to give the following indication:

Generator voltmeter with phase and phase/neutral selector so arranged that the mains voltage could be tested if desired.

Generator ammeter with phase selector

Polyphase kW indicating meter suitable for unbalanced loads.

30.40 As far as practical, all instruments on the panel shall be of similar pattern and finish with 100mm dial and be suitable for flush mounting. An engraved label showing the full load current of the generator shall be fixed to the panel immediately below the ammeter.

30.41 An audible alarm having a distinctive tone shall be provided and shall be actuated on the occurrence of one or more of the following:

Engine failing to start

Engine shutting down when the sensing relay has operated following mains failure

Operation of the generator overload protection.

Failure of one or more phases of the generator supply the set continuing to run.

30.42 A self-re-setting alarm-muting switch shall be provided and connected so that its operation silences the alarm bell but leaves the indicator lamps illuminated.

30.43 The frame or base upon which the engine and generator will be mounted together shall be of robust steel section, rigidly constructed and free from twist and so designed as to maintain proper alignment under all conditions. Frames for units of 200kVA output and above shall be stress relieved. The frame shall incorporate steel plates suitably machined and positioned to each end of the unit to be used for levelling in all directions and have four lifting lugs. All mounting pads for engine and generator shall be fully machined.

30.44 Anti-vibration and shock absorbing devices to be fitted between the main frame and the floor, upon which it shall stand as specified.

30.45 A daily service fuel tank shall be provided having a minimum capacity of eight hours storage, complete with filling orifice, oil strainer, filter, filler cap, ventilation pipe, drain valve with drain hose connection, dial type contents gauge and fuel line between the service tank and the set. The tank shall not be galvanised internally. Between the service tank and the engine injector pumps, an oil filter with easily replaceable elements shall be installed. The filter shall remove all particles down to 0.065mm.

30.46 A wall mounted hand operated semi-rotary fuel transfer pump shall be provided for filling the daily service tank from barrels under emergency conditions. This pump shall have rigid pipework from the discharge to the tank and a suitable length of oil resistant non-collapsible pipe on the suction side. Both the suction and discharge pipes shall be equipped with protective caps or covers to prevent the ingress of dirt and moisture.

31.0 Uninterruptable Power Supplies

31.1 UPS Systems shall be fully automatic and may utilise transistor or thyristor switching techniques.

31.2 The load provided by the UPD and automatic paralleling facilities shall be as shown on the tender drawings.

31.3 The UPS system shall be operated in synchronism with the normal AC mains supply, provide line conditioning and back up power, and be continuously rated to supply the total load. On failure of the normal AC supply, the UPS unit or units shall supply the load via their associated battery and inverter, indication of this condition shall be displayed on the status panel.

31.4 On restoration of the normal AC mains supply, the UPS unit(s) shall accept the load on to the mains and the battery shall revert to normal charging.

31.5 During the change-over periods, the UPS supplied loads shall not be subject to any disturbance in operation.

31.6 In the event of any UPS system failure causing reduction in capacity below the stated load, the system output load shall be maintained by connection to the unregulated AC supply via an automatic by-pass switch. Filtering equipment shall be supplied, as necessary, to meet the output harmonic/transient requirements specified.

31.7 The UPS shall automatically switch-off in the event of the battery reaching its end of discharge condition. On restoration of the normal AC supplies, the UPS shall be connected to the load and at the same time re-charge the battery system.

31.8 The UPS modules shall be self-contained and include an input rectifier filter system.

31.9 A status panel containing long life LED indicators shall be provided on the front of the UPS doors, to clearly identify the operating modes.

31.10 The U.P.S. module should have an AC ripple current (RMS) of less than 1% of d.c. rating of battery supplied (with rectifier or inverter connected) and is designed to provide the maximum lifetime from the sealed lead acid batteries proposed.

31.11 The UPS module output shall be designed to accept non-linear loads with crest factors of up to 3:1 at the kw rating of the UPS module. Any de-rating required, to accept the proposed loads, should be stated.

31.12 The rectifier/charger shall be rated to provide the full inverter input current, and recharge a fully discharged battery simultaneously. Under generator conditions, if applicable, the rectifier/charger shall inhibit battery charging.

31.13 The rectifier shall include a "soft start" facility to limit the rectifier inrush current following a mains

restoration.

31.14 Each mains input shall be provided with transient suppressors to give a level of protection for both phase and line voltages.

31.15 The AC ripple current fed to the battery system shall be less than 1% (RMS) d.c. rating of the battery supplied, and shall be measured with the inverted and rectifier/charger in circuit and carrying full load.

31.16 The inverter shall be rated to provide a specified load under all conditions of AC input supply variation, DC battery voltage and 0 to 100% load changes. The inverter output waveform shall not include a superimposed switching ripple.

31.17 For parallel system, the inverter shall include redundant oscillators and monitoring circuits, such that any single fault can be rapidly detected and the inverter disconnected from the output busbars without break or disturbance to the load.

31.18 Common oscillator or control systems are not acceptable. The oscillator shall operate independently of the mains supply frequency.

31.19 The inverters are to be inherently short circuit proof, without damage to internal components.

31.20 Each UPS module will be fitted with a static interrupter to isolate the inverter from long-term short circuits and protect the system during single module failure.

31.21 The UPS shall be of a low loss, high efficiency design, with module input to output efficiency exceeding 90% from no load to full load.

31.22 The inverters are to be capable of operation with unbalanced loads (typically 50% 50% - 125%).

31.23 All auxiliary power supplies taken from the module input and output shall be monitored and alarmed.

31.24 Full diagnostic and status indication shall be provided for each individual unit and for the system as a whole.

31.25 The following metering shall be provided as a minimum (50 Hz system):

DC charging current

Output/bypass voltage

Output current

Output frequency

Battery DC voltage

Battery current (centre reading, to indicate both charge and discharge)

Input current

Input voltage

Output voltage

High resolution metering shall only be permitted.

31.26 A status panel shall be provided for all UPS cubicles and the system control cubicle to give clear indication for the operation status of the equipment.

31.27 All alarms susceptible to transient response shall be capable of delaying the alarm condition.

31.28 The static by-pass switch shall provide a no-break change-over to by-pass supply provided that the inverters are synchronised to the by-pass supply. A contactor, or similar device, in parallel with the static switch, shall provide direct connection between the load and by-pass supply.

31.29 A switch mounted within the UPS cubicle shall be provided to enable either inverter priority or bypass operation.

31.30 Following a switch over from the inverter(s) to the static by-pass, provision shall be incorporated to switch back to the inverter, provided that the inverter(s) output is within specification. Should the inverter(s) not accept the load due to overload or other reasons, the inverter(s) are to be locked out and an alarm raised. No break or output disturbance to the load shall occur during this switching process.

31.31 The static by-pass shall be mounted within its own cubicle, which shall form part of an integrated design with the UPS enclosure(s).

31.32 The equipment shall be able to be stored in temperatures of –10°C to 70°C, without any deterioration.

31.33 If forced cooling is used, fans must be fully redundant.

31.34 Radiated noise shall not exceed 75 dbA at 1.0 metre unless otherwise specified in the Schedules.

31.35 All cubicles shall be provided with a rigid steel base-frame to allow either direct floor mounting or installation on a supplementary angle or channel framework.

31.36 All equipment shall be suitable for either top or bottom entry of cables, where single core cables are utilized non-ferrous gland plates shall be used.

31.37 The batteries shall be sized to ensure power supply continually to the inverter for the period specified in the event of an outage of the normal input sources with the UPS operating at rated load. Battery ratings will be based on an operating temperature range between 15°C and 26°C. The battery type shall be of the lead acid type valve regulated maintenance free. Batteries shall be mounted in suitably ventilated floor standing cubicles.

32.0 Busbar Trunking Installation

32.1 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.

32.2 High grade insulating panels shall be spaced at frequent intervals to support the busbars and withstand the stresses set up under short circuit conditions. Provisions shall be made for expansion of the busbars.

32.3 A substantial copper earth link shall be fitted external to the trunking to provide an efficient earth continuity path.

32.3 At outlet points, provision shall be made to ensure that "tap-off" units are effectively earthed before their contacts approach the live bars,

32.4 All trunking shall be provided with internal fire barriers where they pass through fire resisting structure. Internal fire barriers shall be cement or glass fibre boards with gaps filled with an approved fire retardant material.

32.5 Trunking runs shall terminate in top end units, which shall incorporate an insulated panel to ensure adequate support for the busbars.

32.6 Manufacturers standard fittings shall be used and shall incorporate the same features and finish as the main busbar trunking.

32.7 Incoming supply points shall be complete with removable cover plates and copper earth links to ensure satisfactory continuity of the system.

32.8 "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.

33.0 Rising Mains Trunking Installations

33.1 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.

33.2 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.

33.3 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.

33.4 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.

33.5 A heavy gauge sheet steel cable entry unit shall be fitted to suit the type of cable specified.

33.6 All trunking shall be provided with internal fire barriers. Internal fire barriers shall be cement or glass fibre boards with gaps filled with glass wool or glass fibre material.

33.7 Coloured P.V.C. sleeving shall be fitted to the conductors where they pass through supports or

fire barriers.

33.8 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.

33.9 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 length of the earth continuity tape shall be 15m or as specified on the drawings.

33.10 All distribution boards shall be securely bonded to this earth continuity conductor.

33.11 Joints shall be riveted with copper rivets and soldered overall after riveting.

33.12 The rising mains shall be so designed, that complete erection can be effected after the building is watertight.

33.13 The system should be arranged so that busbars may be capable of extension with undue disturbance of other equipment.

33.14 Incoming supply points shall be complete with removable cover plates and copper earth links to ensure satisfactory continuity of the system.

33.15 "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.

34.0 High Voltage Switchgear

34.1 High voltage switchgear shall comply with the current edition of the E.S.I. (Electricity Supply Industry) Standard 41-5 for voltages up to 11kV and fault level rating up to 350 MVA. Evidence that the switchgear has been A.S.T.A. certified for the fault level specified shall be provided.

34.2 The system voltage, fault level, type of switchgear, protective system, metering, interlocking arrangements and labelling will be specified in the Schedules or drawings.

34.3 Switchgear shall be complete with cable boxes, glands, armour clamps, cable connectors, earthing bar, earthing connectors; floor fixing bolts an all-necessary sundries.

34.3 The high voltage switchgear shall comprise incoming and transformer feeder circuit protective devices together with interconnecting busbars, protection relays, current and potential transformers, ammeters and voltmeters.

34.4 The switchgear shall be manufactured in accordance with the relative British Standard.

34.5 All current carrying parts shall be copper. Aluminium or copper coated aluminium shall not be used. Copper busbars shall be continuously rated and of uniform section throughout. Contacts shall be faced with silver or other durable material.

34.6 The appropriate certificates from a recognised testing authority shall be provided to show that the performance of the switchgear is in accordance with British Standards.

34.7 All Switchgear and control gear shall be extendable flush fronted, freestanding metal clad in accordance with the relative British Standard. Open-type switchgear shall not be used. Live parts of any description inside panels and switchboards shall be covered or otherwise protected from accidental contact to the degree IP3X.

34.8 All controls, indicating instruments and relays shall be accessible from the front and low voltage wiring, fuses, connectors, timers, interlocks, etc., shall be in compartments separated from high voltage conductors. Instruments and controls shall be mounted on hinged doors at the front of each panel.

34.9 The switchgear as a whole shall be capable of carrying the short circuit current for a minimum of three seconds. Rated voltages, insulation levels, frequency, normal current, short time current, peak withstand current and temperature shall be in accordance with the relative British Standard.

34.10 The switchboard shall have integral busbar and feeder earthing facilities. Earthing conductors shall be copper. Doors shall be earthed by means of flexible braided copper conductors; hinges shall not be relied on for earthing purposes.

34.11 Labels shall be of Formica engraving laminate giving black lettering on white background and shall be mounted on both front and rear of each panel, using two or more brass fixing screws. Withdrawable items such as circuit breakers and voltage transformers shall be clearly labelled to identify the panels to which they belong.

34.12 Each automatic circuit breaker shall conform to the relative British Standard and shall contain the following:

i) Voltmeter and selector switch
ii) Ammeter and selector switch
iii) Earth fault protection
iv) Over current protection
v) Shunt trip coil
vi) Emergency trip button (mechanical)
vii) Earthing switch mechanism
viii) Lockable busbar shutters with 'Danger High Voltage' labels fitted Manual trip/close facility a minimum of 2No. and 2 NC auxiliary contacts (volt free)
ix) Manual trip/close facility
x) A minimum of 2No. and 2NC auxiliary contacts (volt free)

34.13 Circuit breaker rating shall comply with BS5311 standard values.

34.14 Closing of circuit breakers shall be by independent charged spring operation. Springs shall be capable of being charged manually and automatically.

34.15 Interlocks shall be provided to ensure that all stored energy is discharged before circuit breaker tanks are removed.

34.16 All circuit breaker closing mechanisms shall be trip-free with momentary full closing of contacts.

34.17 Circuit breakers operated by weights or by pneumatic or hydraulic mechanism shall not be used.

34.18 Isolation shall be by vertical or horizontal withdrawal and earthing of busbars and feeders shall be by position of the circuit breaker or by use of purpose made earthing/testing devices, both systems having suitable interlocks to prevent mal-operation. Safety shutters shall be automatic and lockable in the closed position but not lockable in the open position.

34.19 Instruments, relays, control buttons, auxiliary switches, trip coils, metering, protective equipment and secondary wiring shall be in the fixed portion of the circuit breaker to minimise or eliminate secondary contacts between withdrawable circuit breaker and fixed portion.

34.20 Busbars shall be hard drawn high-conductivity solid copper, they shall be PVC insulated, colour coded and supported by cast resin insulators giving adequate clearance throughout. Tee-off connections shall be insulated by resin mouldings.

34.21 Cable boxes, glands and terminals shall be suitable for the type, size and number of cables they are required to accept. Cable entry shall be at the rear and cable boxes shall be designed so that cables may approach from any direction. Separate terminal boxes shall be provided for low voltage multi-core cable for interconnection and metering purposes. The minimum clearance between finished floor level and cable gland shall not be less than 300mm.

34.22 Current transformers shall be bar type or wound type as appropriate for the primary current and shall have the correct turns ratio to give a secondary current of 5A, unless exceptionally long leads dictate an output of 1A. Core balance current transformers shall be used for earth fault indication. Current transformers for metering instrumentation shall be low saturation level type and those for protection shall be high saturation type, the classes of accuracy being appropriate for the kind of protection used.

34.23 Meter and instrument current transformers should be Class BM or CM. Insulation shall be cast resin or butyl rubber. Provision shall be made to prevent danger or damage in the event of accidental open circuit of current transformers.

34.24 Voltage transformers shall be of the withdrawable type with high voltage and low voltage fuses. Fixed contacts shall be protected by automatic shutters when transformers are withdrawn. Output voltage shall be 110V. Insulation shall be cast epoxy resin. Common meter, instrumentation and protection voltage transformers may be used except for directional earth fault protection where residual voltage transformers for meters and instrumentation shall be Class B.

34.25 Provision shall be made for access to the fixed portion spouts for the purpose of current injection and voltage application for testing purposes. Any special devices necessary for access to spouts for connection for testing purposes shall be provided.

34.26 Instrument and control circuit fuses shall be suitably colour coded and labelled. Terminals of fuses shall be shrouded if the voltage exceeds 50V. The shrouding shall prevent accidental contact when fuses are withdrawn.

34.27 Individual items such as switching devices, transformers, instruments and relays shall be constructed to satisfy the British Standard for the particular item.

34.28 The switchboard shall be manufactured of steel with sheet steel partitions. Frames shall be

rolled angle section and sheets shall be of the thickness not less than 2mm. The whole construction shall be robust enough to comply with the short circuit requirement.

34.29 All steel surfaces shall be cleaned, primed with a rust inhibiting primer and given at least two coats of paint. All primers and paints shall be to British Standards. The final coat shall be a semi-gloss finish. Colour shall be from manufacturers standard range unless particular colours are specified on drawings or schedules.

34.30 Any damage to finishes shall be made good with the same paint as the original finish, prior to testing and commissioning.

34.31 Castell interlocks shall be provided as shown on the schematic drawings.

34.32 Keys shall be available at the time of works testing of switchgear.

34.33 Opening releases shall be operated on a d.c supply of not less than 50V obtained from sealed alkali batteries dedicated exclusively to that purpose. The batteries shall be enclosed on a purpose made wall mounted sheet steel cabinet complete with automatic charger and fault indicators, facilities for remote monitoring of operations and faults shall be provided, the system being specifically designed and rated for the operation of opening releases.

34.35 Tests shall be carried out in the manner prescribed in the relevant British Standards. Test shall be made at manufacturers works prior to shipment and repeated on site after installation.

34.36 Tests shall include but are not restricted to the following:

Visual inspections and check against drawings and schedules

Mechanical operations, including interlocks and opening releases

Insulation Tests

High voltage tests as BS 5227, Section Seven

Tests of instruments and relays by primary and secondary injection.

Typed test reports shall be provided for making, breaking and short circuit tests and for temperature rise tests.

Test certificates shall be provided for current transformers, voltage transformers, instruments and relays.

Inspection and Testing Records shall be provided as required by the Sub-Contract Documents.

All necessary loose equipment required for operation and maintenance of the high voltage switchgear shall be provided, including circuit-breaker handling equipment, lifting tackle and tools.

Lockers and wall racks shall be provided as necessary for secure storage of loose equipment.

35.0 Transformers

35.1 The voltage rating and type will be specified in the schedules or drawings.

35.2 Oil immersed, naturally cooled transformers shall comply with the current edition of the E.S.I. (Electricity Supply Industry) Standard 35/1 and shall b complete with first filling of oil.

35.3 Dry, air-cooled transformers shall comply with BS171.

35.4 All transformers shall be complete with cable glands, cable boxes, armour clamps, skids and all sundries.

35.5 As far as practicable, the transformers shall have the maximum number of common parts and accessories supplied by the same manufacturers.

35.6 HV and LV cable boxes shall be mounted on opposite sides of the transformer.

35.7 Each transformer shall be provided with lifting lugs or eyebolts to facilitate handling by crane.

35.8 Each transformer shall be provided with switched (off-load) tappings on the HV winding to cater for supply voltage variation of +22% and +5. Tap changing shall be made by off load switches in a protective enclosure having a transparent cover. Tappings shall be clearly marked to indicate the taps in use from an external view. Each tap changing enclosure shall have a visible warning notice fixed adjacent to it and worded as follows:

'WARNING - OFF LOAD TAP CHANGER' 'ISOLATE HV AND LV SUPPLIES TO TRANSFORMER BEFORE OPERATION'

35.9 HV and LV winding terminals shall be clearly marked with characters in accordance with BS171. The characters shall be stamped or engraved on securely fixed, durable and non-corrodible plates.

35.10 Phase colours may be used in addition, but are not acceptable as an alternative.

35.11 The LV cables terminals shall be suitable for three-phase and neutral connections. The LV star point shall be an insulated connection similar to the LV phase connections and will be earthed.

35.12 All metalwork not forming a conductive part shall be suitably bonded together and means shall be provided to facilitate the connection of external earth tapes or cable to the bonded metal.

35.13 Each transformer shall be provided with a dual temperature sensing system to operate separate remote warning and tripping equipment.

35.14 Each transformer shall be fitted with rating and diagram plates in accordance with the requirements of ESI Standard 35/1.

35.15 Each transformer shall contain the following:

i) Winding temperature alarm and trip device complete with indicator

ii) Coolant level sight glass

iii) Pressure relief valve, self-sealing

iv) Drain with screwed plug

v) Off-load tap changing device +2/5% and +5%

vi) Non ferrous gland plates on LV terminal chamber

vii) Dial type thermometer and pockets

viii) Oil filling hole and screwed plug

ix) Skids and provisions for rollers

35.16 Each transformer shall be constructed so as to provide an adequate means of ventilation for cooling purposes based upon an ambient condition maximum of 35°C with 30°C outside ambient conditions with the transformer operating at full load.

35.17 Each transformer shall be manufactured and tested in accordance with the appropriate British Standard or as specified.

36.0 Outdoor Distribution Pillars

36.1 Outdoor distribution pillars shall comprise open back distribution and isolating link units of the ratings and ways specified, complete with busbar system and phase dividing fillets, all mounted on mild steel supported bars in a cost iron or steel shell.

36.2 The distribution and link units shall be complete with insulting bases fitted with busbar and outgoing conductor fittings.

36.3 Fuse-link carriers shall be the porcelain wedge-blade type fitting with wedge-type cartridge fuse links to BS88 with slotted tags. Neutral links also shall be wedge-type.

36.4 Isolating link units shall be fitted with hinged bolted links for the phases with a withdrawable bolted link for the neutral.

36.5 The shell shall be built of cast iron or steel throughout with removable panels at the back and doors with brass hinges at the front. The doors shall be fitted with a recessed barrel lock with flush brass screwed plug. The shell shall be so constructed to ensure ample ventilation, the ventilators having insect barriers and be complete with a separate cast iron root bolted to the shell.

36.6 Pillars shall be complete with insulated combined lifting handle and screwdriver suitable for operating wedge-type links, a combination door key suitable for removing brass plug and operating lock, circuit identification labels, circuit chart mounted on inside of door and angular type sealing boxes for the cable specified. A storage bracket shall be provided inside the pillar for the insulated combined lifting handle and screwdriver.

36.7 Sealing boxes shall be supplied complete with sealing compound suitable for the type of cable6 specified.

36.8 During installation the pillar root shall be bolted firmly to the plinth and the pillar shell shall be

made secure and vertical. Roots shall be fitted with sheet steel aprons as specified an both roots and aprons shall be protected with an approved bituminous compound and the pillar shell painted with a coat of flat and two coats of gloss paint.

36.9 After cabling work at pillars is completed, the void in the root within the pillar shall be filled with sand, well rammed down and the sand covered with bitumen compound to minimise rising damp.

37.0 Earthed Concentric Wiring Installations

37.1 Earthed concentric wiring shall be employed only when particularly specified.

37.2 The cable employed shall be M.I.M.S. and the fittings used shall be as standard for M.I.M.S. installations, except that every box shall have an earth terminal.

37.3 Unless otherwise specified, when used on a D.C. system the outer sheath shall be negative in relation to the inner conductor. When used on an A.C. system the outer sheath shall be connected to the neutral point of supply.

37.4 All glands used shall incorporate earth tails or, if earth tail seals are not available for the size of cable, approved earth clamps with tails. The neutral conductor shall be solidly connected from the point of supply to every point in the installation, and duplicate continuity shall be provided by interconnecting the earth tails at junctions and termination. Continuity shall not be dependent only on contact between the cable seal and gland.

37.5 Section and distribution fuseboards shall be enclosed in metal and shall be internal neutral connecting blocks to which all earth tails shall be connected.

37.6 The neutral point of supply and the sheaths of all distribution cables shall be bonded together at the distribution fuse board.

37.7 All switch and outlet boxes used shall be metal with earth terminals.

37.8 A short tail shall be taken from the earth terminal to the neutral of all appliances.

37.9 All socket outlets shall have duplicate cable bonds to the neutral pin, which shall be earthed to the box and earth pin.

37.10 All cable sheaths and all metalwork associated with the electrical fitting or in contact with, or in close proximity to, the cable shall be effectively bonded to earth so that at no point in the installation is the total resistance to earth more than 0.5ohm.

37.11 If the electricity supply is obtained from a transformer fed at high voltage, the medium voltage installation shall be earthed to a separate earth electrode.

37.12 This earth electrode shall be outside the resistance area of the transformer high voltage earth electrode, and no metallic connection shall be made between these two earths.

37.13 No metalwork forming part of a telegraphic, telephone or signalling circuit belonging to the Post Office or forming part of a radio, internal telephone call or indicating system shall be bonded to the metal sheath of the earthed sheathed return wiring. Where adequate separation is impracticable, insulating material shall be used to prevent electrical contact taking place.

38.0 Installation in Explosive Atmospheres

Division 0 Areas

38.1 The installation shall be as detailed in the specification and on the drawing.

Division 1 Areas

38.2 The wiring system shall be one of the following as specified:

i) Armoured cable.

ii) M.I.M.S. cables and flameproof glands.

iii) Single or multi-core PVC insulated cables enclosed in solid drawn heavy gauge screwed steel conduit, protected against corrosion. Seals and barrier boxes shall be provided at all points where the conduit enters or leaves a safe area. All conduit boxes and fittings shall be of the flameproof type.

38.3 All electrical equipment shall be certified flameproof to BS229 or intrinsically safe to BS1259 and installed in accordance with CP 1003 Part 1.

Division 2 Areas

38.4 Where wiring is connected to equipment that sparks in normal operation, the system used shall be as for Division 1 Areas.

38.5 Where wiring is connected to equipment that does not spark in normal operation, one of the following system shall be used as specified:

i) M.I.M.S. cables.

ii) Single or multi-core PVC insulated cables enclosed in welded heavy gauge screwed steel conduit protected against corrosion. Seals and barrier boxes shall be provided at all points where the conduit enters or leaves a safe area.

38.6 All electrical equipment shall comply with BS 4137 and installed in accordance with CP 1003 Part 1.

BENNETT WILLIAMS

BUILDING SERVICES CONSULTANTS

Mechanical Services Standards

And

Workmanship Clauses

Date:	September 2021
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Contents

Contents

1.0 General

1.1 This section of the Specification prescribes the minimum standard requirements for materials and installation practice. Where clauses conflict with other parts of the specification or drawings the most onerous clause shall be deemed to have been included. Certain Clauses may not be relevant to particular contracts, and should therefore be disregarded.

1.2 All the works carried out within this contract shall be in compliance with the following standards and good working practice.

i) Health and Safety at Work Act
ii) Offices and Shops and Railway Premises Act
iii) Relevant British and European Standards and Codes of Practice
iv) Supply Authority Guidance and Recommendations
v) Electricity at Work Regulations
vi) Building and Engineering Services Association (BESA) formally HVCA
vii) Electricity (Factories Act) Special Regulations
viii) The latest edition of the IEE Wiring Regulations
ix) Manufacturers installation guidance and recommendations
x) Institution of Gas Engineers and Managers (IGEM) Standards

2.0 Pipework

General

2.1 Pipework installation and testing shall be generally undertaken in compliance with the following BESA/HVCA standard documents.

TR20	Part 1	-	Low Temperature Hot Water Heating
TR20	Part 2	-	Medium Temperature Hot Water Heating
TR20	Part 3	-	High Temperature Hot Water Heating
TR20	Part 4	-	Hot Water Services
TR20	Part 5	-	Cold Water Services
TR20	Part 6	-	Chilled Water
TR20	Part 7	-	Condenser and Cooling Water
TR20	Part 8	-	Steam and Condensate
TR20	Part 9	-	Natural Gas
TR20	Part 10	-	Oil

2.2 Runs of pipework shall follow the lines of walls, floors etc, and the Sub-Contractor shall arrange all runs to avoid unsightliness and suit site conditions. Vertical pipes shall be truly plumb. Pipework is shown on the drawings as accurately as possible but the Sub-Contractor shall provide additional bends, sets etc., to avoid columns, beams and other services as may be necessary. All pipework is to be graded with a rise or fall to permit adequate venting and easy drainage. Particular care shall be taken in the setting out of pipework in boiler and plantrooms to allow for ease of access for maintenance of all plant.

2.3 The following minimum clearances shall be maintained wherever possible.

Walls	-	25mm
Ceilings	-	150mm

Floor	-	150mm
Adjacent	-	25mm (including insulation if possible)
Electrical Services	-	100mm

2.4 Where pipes are to be run in banks of two or more the Sub-Contractor shall take special care in setting out to avoid unsightliness. Where pipes are to be insulated after erection then sufficient space shall be maintained for subsequent insulation application, the final clearances being as stated above.

Quality of Pipework

2.5 Where not covered by BESA/HVCA TR20 the quality of pipework used in the various installations shall be as follows:-

Service		**Materials**
Cold Water Services (underground external)	-	MDPE Protecta-Line or equivalent
Gas Service (external)	-	(a) M.S. tube to BS1387 heavy quality - at entry points only
	-	(b) Polyethylene tube S.D.R. 2 medium density to British Gas Specification G.C.PS/PL2
Compressed Air	-	(a) M.S. tube to BS1387 Heavy quality galvanised
	-	(b) Solid drawn copper tube to BS2871 Table X
Sprinkler pipework	-	M.S. tube to BS1387 Medium Quality
Dry risers and foam pipework	-	M.S. tube to BS1387 Medium Quality galvanised

Pipework Fittings

2.6 Except where otherwise indicated all bends and tees shall be of standard dimensions easy sweep pattern having dimensions in accordance with British Standard details. No elbows shall be used anywhere in the installation without the Engineers consent except on the gas service. All reductions in horizontal mains shall be made with eccentric reducing sockets to prevent air pockets. Reductions in vertical mains shall be made with concentric reducing sockets. Under no circumstances shall fittings be bushed to reduce outlet sizes. Reducing tees shall be used, wherever possible. All fittings shall be stamped with the B.S. 'Kite mark'.

Screwed Fittings

2.7 On screwed steel pipework malleable iron fittings shall be used of the beaded or banded type to BS143 black finish except for galvanised pipework where the fittings shall also be galvanised. All fittings shall be of the best quality with accurately screwed threads to BS.21.

Welded Fittings

2.8 On welded pipework butt welding fittings to BS1965 shall be used medium or heavy weight to suit the particular service.

Copper Alloy Fittings

2.9 All fittings on copper pipework 54mm dia and under shall be in gun-metal or copper of the compression joint manipulative type or alternatively of the capillary soldered type to BS864. Copper alloy fittings and solders for use on potable water supply shall be lead-free to comply with the Water Bye-Laws.

2.10 Fluxes shall be non-toxic.

2.11 On pipework of 76mm dia and over gun-metal brazing fittings shall be used. All brazing materials shall be free of zinc content.

2.12 Where pipework is connected to tanks, ball valves, taps etc., suitable connectors shall be used.

Cast Iron Fittings

2.13 On cast iron pipework all fittings shall be cast iron to BS4772 concrete lined or plain to suit the particular service.

Plastic Fittings

2.14 On polythene pipework fittings shall be of the gun-metal compression type with suitable inserts.

2.15 On uPVC pipework fittings shall be of the same material as the pipe, made by or approved by, the pipe manufacturer and suitable for solvent welding.

Pipework Jointing

General

2.16 All screwed joints on LTHW pipework shall be made with either hemp and jointing paste or PTFE tape. Surplus hemp and jointing compound shall be cleaned from all joints after erection.

2.17 Screwed joints to compressed air or steam pipework shall be made with suitable jointing paste. Hemp or PTFE shall not be used.

2.18 Pipes shall be arranged so that no joints occur within the thickness of walls, floors and ceilings or similar inaccessible positions. During the erection of all installations care shall be taken to ensure no dirt or rubbish enters the pipework, should any stoppage of circulation occur due to this the Sub-Contractor shall rectify that at his own expense. Where pipes have to be left during installation caps, only manufactured plugs or purpose made blanking fittings shall be used to protect the open ends.

Disconnection of Pipes

2.19 An adequate number of connectors shall be used, to permit disconnection and removal of any section of pipework without undue disturbance. On pipes up to and including 65mm dia unions

shall be used; on pipes over 65mm dia. The connections shall be flanged.

2.20 Branch welds on low pressure pipework shall be fitted with unions or flanges adjacent to the branch. Unions shall also be provided on the dead side of screwed valves and adjacent to all items of plant.

2.21 The use of long screws or back nuts shall not be allowed.

Flanges

2.22 All flanges shall be to BS.4504 to the appropriate PN table to suit the service/test conditions. Flanges shall be cast iron, bronze or cast steel to suit the particular service, of the lip-on-type welded or screwed as appropriate. The joint shall be made with suitable joint ring, mild steel hexagonal bolts, nuts and washers. Not less than two threads shall project through the nut when it is drawn up tight.

Welded Joints

2.23 The execution of welding and the competence of the operative shall be in accordance with BS.2640 (oxyacetylene welding methods for Class II conditions) or BS.2971 (arc welding methods for Class II conditions) and the recommended practice for oxyacetylene welds in M.S. pipelines by the Heating and Ventilation Contractors Association.

2.24 Ends of pipes shall not be flame cut but shall be machined, the burrs removed with a reamer and the ends trimmed to give an angle joint for welding. Butt welds shall be made so as to fuse completely pipe walls with a penetration to produce an internal bead of not more than 1.5mm. At branches and tee positions purpose made welding fittings shall be used, the practice of using branch pipes welded directly to mains shall not be allowed. The distance between two branch welds shall not be less than twice the diameter of the main. Unions or flanges shall be fitted immediately after each branch position.

2.25 Care shall be taken to ensure that the welding material or flux does not project into the bore of the pipe. All welds shall be of good clean metal free from slag inclusions and porosity, of even thickness and regular contour, well fused with the parent metal, annealed and hammered upon completion.

2.26 Every precaution shall be taken to prevent damage by scorching or fire. Suitable fireproof mats and portable fire extinguishers shall be provided for use in an emergency. During all welding and cutting operations the welder shall be accompanied by a competent assistant.

2.27 After welding joints shall be ground or filed smooth and painted immediately with red oxide primer.

Water and Steam above Ground

2.28 All LTHW pipework in plantrooms, ducts, chases, floor trenches and ceiling voids shall be welded except for connections to valves, unions or equipment which shall be flanged or screwed. Elsewhere pipework may be screwed or welded.

2.29 All steam, HTHW and MTHW pipework shall be welded with flanges at valves and equipment only.

2.30 Copper pipework for water systems of up to 54mm dia. Shall be jointed with gun-metal compression fittings or alternatively gun-metal or copper capillary soldered fittings. On sizes of 74mm dia. And over brazing shall be employed.

2.31 Copper pipework for condense systems shall be joined with high temperature type gun-metal or copper capillary soldered fittings.

Water Underground

3.32 Pipework carried out in polythene shall be joined by suitable gun-metal compression joints.

2.33 Pipework carried out in uPVC shall be joined together with solvent welded joints to the pipe manufacturers recommendations.

2.34 Pipework carried out in ductile iron pipework shall be jointed with socket and spigot Tyton joints or equal and approved installed in accordance with the manufacturers recommendations.

Gas Above Ground

2.35 Copper pipework for use on gas shall be jointed with gun-metal or copper capillary soldered fittings. All gas steel pipework shall be welded, except for connections to valves, cocks and equipment which shall be screwed.

Gas Underground

2.36 Gas pipework carried out in ductile iron pipework shall be joined with socket and spigot bolted ring type joints to Gas Board requirements 'Stanlock' or equal and approved. Pipework carried out in steel shall be welded. Pipework carried out in polyethylene pipework shall be joined by solvent welding to British Gas Specification G.C. PS/PL2.

Fuels and Oils

2.37 All fuel oil, lubricating oil and diesel pipework buried in floors or in other inaccessible positions shall be welded. Elsewhere the pipework shall be screwed.

2.38 All petrol pipework shall be screwed. All screwed joints shall comply with BS21

2.39 All screwed joints made on fuel oil, diesel, lubricating oil or petrol pipework shall be made with approved impervious jointing paste only.

Unions

2.40 All unions for use of steel pipes shall be of malleable iron with two bronze spherical seats. On copper pipework gun-metal soldered, connectors shall be used.

Brackets and Supports

2.41 The Sub-Contractor shall include for a complete system of supports and brackets necessary to support the services from the building structure. The services shall be supported in such a manner as to allow for expansion and contraction, suitably graded for drainage and air elimination. Pipework shall be supported at the maximum centres shown however, in the case of multiple runs the smallest pipe shall determine the support centres. Additional supports shall

be provided at bends, changes of direction, valves, branches and where pipework connects to heavier equipment, to ensure all pipework is adequately supported.

2.42 Guides made of 'U' bolts or formed from flat steel shall be provided where necessary to restrict lateral movement.

2.43 Horizontal pipes in ceiling voids, ducts and the like are to be supported by split band brackets, munzon rings or the like with swinging joints and drop rods. Where space does not permit the use of rods to cater for expansion then rollers and chairs shall be used. In the case of major service runs in ducts ceiling voids and the like, the individual pipe supports shall be suspended from suitable sized mild steel sections securely fixed to the building structure.

2.44 Vertical pipes passing through more than one floor in multi-storey buildings shall be securely fixed at one point only, and other pipe brackets arranged to permit expansion and contraction.

2.45 Where pipes run near the floors in areas where they are likely to be stood upon additional supports shall be provided, taken from the floor to prevent deflection.

2.46 When fixing to lightweight partitioning and the like care shall be taken to ensure that pipework is adequately supported. Use shall be made of timber noggins and special plugs if necessary.

2.47 Particular care shall be taken with the bracketing of pipework exposed to view in rooms to ensure a neat appearance. In these areas screw-on type pipe clips shall be used of malleable iron or non-ferrous to suit the service, with plated or brass wood screws and plastic plugs.

2.48 The Sub-Contractor shall include for all drilling of brick, concrete, structural steelwork etc., necessary for the fixing of bracketing systems to the building structure. Where drilling of structural steelwork or concrete is involved then the Engineers approval must first be obtained. Expansion bolts shall be installed in accordance with the manufacturers recommendations.

2.49 In general services shall be supported from roof trusses, lattice beams etc., by mechanical clips rather than by drilling. No cutting of, or welding to structural steelwork shall be allowed unless the Engineer's approval has been obtained in writing.

2.50 All bracket assemblies shall be delivered to site with a protective coat of primer. Where proprietary items are used, these shall have the manufacturers standard finish.

2.51 All steelwork used for supporting external services exposed to the weather shall be galvanised prior to delivery to site and assembled with rustless fittings.

2.52 The Sub-Contractor shall ensure that no dangerous edges or corners are left on bracketing systems. Anything of this nature shall be ground off.

2.53 All brackets used on copper pipework shall be either cast brass or gun-metal with brass screws. All brackets for steel pipework shall be malleable iron or steel. Pipe brackets shall be galvanised or chromium plated where pipework is specified to be so treated.

2.54 In general steel and copper pipework up to 65mm diameter shall be supported by munzon rings. Larger pipework is to be supported by purpose made split band clips manufactured from mild steel strip with bolts, nuts, washers and drop rods. Clips for copper pipework shall be lined with copper or some other approved inert material.

2.55 On chilled water pipework oversized brackets shall be used with continuous wooden spacing pieces being used to support the pipe. The overall diameter shall be equal to the inner diameters of the vapour seal barrier this being formed over the bracket to prevent condensation.

2.56 Where the Sub-Contractor wishes to use a proprietary system of bracketing then he shall first obtain the approval of the Engineer.

2.57 Additional supports shall be provided at heavy items of equipment to ensure the weight is not carried by the pipes.

Spacing of Pipework Supports

MILD STEEL PIPEWORK

Size of Main Bore

	Intervals for Horizontal Runs		Interval for Vertical Runs
	BARE	**LAGGED**	**BARE OR LAGGED**
15mm	1.830m	1.830m	2.430m
20mm	2.430m	2.430m	3.050m
25mm	2.430m	2.430m	3.050m
32mm	2.730m	2.430m	3.050m
40mm	3.050m	2.430m	3.650m
50mm	3.050m	2.430m	3.650m
65mm	3.650m	3.050m	4.580m
80mm	3.650m	3.050m	4.580m
100mm	3.650m	3.050m	4.580m
125mm	4.580m	3.650m	5.500m
150mm	5.500m	4.580m	5.500m
200mm	6.100m	5.500m	6.700m

COPPER PIPEWORK

Size of Main Bore

		Intervals for Horizontal Runs	Interval for Vertical Runs
	BARE	**LAGGED**	**BARE OR LAGGED**
15mm	1.220m	1.220m	1.830m
22mm	1.830m	1.520m	2.430m
28mm	1.830m	1.520m	2.430m
35mm	2.430m	1.830m	3.050m
42mm	2.430m	1.830m	3.050m
54mm	2.730m	1.830m	3.050m
76mm	3.050m	2.430m	3.650m
108mm	3.050m	2.430m	3.650m
133mm	3.650m	3.050m	3.650m
159mm	4.580m	3.650m	3.650m

2.58 Supports generally shall be at the spacings given above, but in the case of more than one pipe, the smaller bore shall determine the spacing.

Pipe Sleeves

2.59 Suitable sleeves of mild steel or copper to suit the pipe shall be provided and installed at all points where possible, where pipes pass through walls, ceilings and floors.

2.60 Sleeves shall be in one length and shall generally finish 3mm above the finished surface of floors and walls. Inset areas sleeves shall finish 25mm above the finished floor surface. Sleeves shall be installed in such a manner to allow expansion and contraction of pipework to take place without restriction. Sleeves will not be required where pipework pass through purpose made holes (not being fire barriers) within the depth of ceiling voids. At walls which are fire barriers the Sub-Contractor shall provide and apply suitable fire stopping between the sleeve and pipe.

2.61 Where pipes pass through external walls of buildings the Sub-Contractor shall provide a suitable puddle flange or sleeve for building in by the Main Contractor. If a puddle sleeve is provided the Sub-Contractor shall include for sealing the space between the sleeve and pipe to prevent ingress of water.

Wall and Floor Plates

2.62 Wherever possible, where pipes pass through structures, and are visible in occupied areas, suitable hinged wall, floor or ceiling plates shall be provided and fitted. These shall be fixed by a method that does not restrict the movement of the pipe due to expansion.

Expansion and Contraction

2.63 Pipe runs for all services shall be arranged and bracketed so as to allow for expansion and contraction without undue strain on pipework bracketing or structures. Wherever possible advantage is to be taken of changes in direction of pipework to take up expansion, but no turning forces shall be imposed on screwed joints.

2.64 Where necessary pipe sleeves shall be of a diameter that will allow for lateral movement of the pipe due to expansion and contraction and the pipe shall be fixed correctly to allow for this movement. This shall also apply to holes in structures where it is not possible to fix sleeves.

2.65 Where necessary the Sub-Contractor shall provide and install purpose made anchors of adequate construction to resist the imposed loads.

2.66 At connections to items of plant particular care shall be taken to ensure no undue strain is imposed on the connections due to expansion and contraction of pipework.

2.67 The Engineer will hold the Sub-Contractor responsible for any damage caused to structures, pipework or plant due to neglect of precautions against movement due to expansion and contraction.

2.68 Where purpose made expansion joints or loops are to be provided, the Sub-Contractor shall install these in accordance with the manufacturers recommendations and all necessary brackets and guides shall be provided and installed.

Venting and Draining

2.69 Pipework is to be laid to falls for venting and draining purposes, and it shall be possible to vent and drain all parts of the system. Minimum falls shall be 1:250.

2.70 Systems shall be arranged to vent through radiators and other equipment wherever possible. At all other points where air may collect, where it is not possible to vent via equipment, then the Sub-Contractor shall provide adequate means of venting, these shall generally be air bottles constructed from a 200mm length of not less than 40mm dia steel or copper tube, as appropriate, complete with air cock. Where the bottle is in a position which is not easily accessible then an 8mm dia bleed pipe shall be run down to a convenient position terminating with a key-operated needle valve. Automatic air eliminators shall be provided and fixed where indicated. They shall have gun-metal bodies and stainless steel floats and working parts, and be capable of being isolated from the system by a lockshield valve. From each eliminator a bleed pipe shall be run to discharge at a visible point, where water discharge would not cause damage. The Sub-Contractor shall ensure that the correct type of automatic air eliminator is installed at points where system pressure is low to avoid air being drawn into the installation.

2.71 Drain points shall be provided at all low points in the systems and a sufficient number shall be provided to enable every part of the system to be completely drained. Drain points shall also be provided after each isolating valve to enable individual circuits to be drained down. On large diameter pipework and on items of plant bronze drain cocks shall be used. Hattersley fig. no. 81HU or equal and approved, with hose union. On smaller diameter pipework bronze draining taps shall be used, Hattersley fig. no. 871 or equal and approved.

3.0 Valves

3.1 In general all valves shall be suitable for the operating temperature and working and test pressures of the respective systems, and be line size unless otherwise indicated.

3.2 Bodies of valves and cocks up to 50mm size shall be cast gun-metal or bronze. Bodies of valves 65mm size and over shall be of cast iron or steel. All castings shall be of good quality free from scale and flaws. All working parts shall be of gun-metal or stainless steel alloy. Stuffing boxes shall be correctly packed to suit the particular service. Valves and cocks in mild steel pipework up to 50mm size shall have taper screwed ends. Valves and cocks of 65mm size and over shall have flanged ends suitable for the working and test pressures of the respective system. Valves and cocks on copper pipework shall have capillary, compression or flanged ends to suit the size and installation. Valves and radiators, convectors etc, shall have union ends and plastic handwheels or shields shaped to enclose the spindle and gland. All valves shall have renewable seats and discs and be accessible for operation and maintenance. Valves shall be fitted to isolate each item of plant or equipment without affecting the remainder of the installation; and also to effectively regulate the systems for commissioning purposes.

3.3 Valve handwheel/levers shall have extension sections provided where pipework is to be thermally insulated.

3.4 All valves shall have the manufacturers name, material designation, pressure rating, size and B.S. Kite mark clearly marked on the valve body. Additionally, all stop cocks, check valves and strainers shall have an arrow indicating flow direction.

3.5 Valves shall be of a similar quality to Hattersley manufacture in accordance with the following schedules:-

Application	Valve Type	Size Range	LTHW – Max 90°C	MTHW – Max 120°C	CHW
Isolation	Ball/Gate	15mm – 50mm	100/30	100/30	100-EXT/30
	Butterfly	65mm – 300mm	950,970 or 4970	950, 970 or 4970	950, 970 or 4970
Check	Swing	15mm – 50mm	47	47	47
	Wafer/Swing	65mm – 651	861/651	861/651	861/651
Double Check		15mm – 50mm			
		65mm – 300mm			
Regulating (1)	DRV	15mm – 50mm	1432	1432	1432
	Butterfly DRV/ Globe	65mm – 300mm	953W /MH733	953W/MH733	953W/MH733
Flow Measurement (1)	Metering Stations	15mm – 50mm	1000	1000	1000
		65mm – 300mm	M2000-PN16	M2000-PN16	M2000-PN16
Commissioning (1)	FODRV	15mm – 50mm	1732 M3000-PN25	1732 M3000-PN25	1732 M3000-PN25
	FODRV	65mm – 300mm	MH2733	MH2733	MH2733
	Metrex Units	65mm – 300mm	5953/5973	5953/5973	5953/5973
DPCV	Flow or Return Mount	15mm – 50mm	F400/R400	F400/R400	F400/R400
	Return Mount	65mm – 150mm	405F	405F	405F

MECHANICAL SERVICES STANDARD AND WORKMANSHIP CLAUSES

Application	Valve Type	Size Range	LTHW – Max 90ºC	MTHW – Max 120ºC	CHW
PICV		15mm – 50mm	1932	1932	1932
		50mm – 150mm	306F	306F	306F
		20mm – 250mm	305F	305F	305F
Press-Fit	DRV	15mm – 50mm	1432.PF	1432.PF	1432.PF
	FODRV	15mm – 50mm	1732.PF	1732.PF	1732.PF
	Ball	15mm – 50mm	100.PF	100.PF	100.PF
	Check	15mm – 50mm	47.PF	47.PF	47.PF
	Strainer	15mm - 50mm	817.PF	817.PF	817.PF
Strainers		15mm – 50mm	817	817	817
		65mm – 300mm	822/922	822/922	822/922
Drains		Plant/Rm	81HU	81HU	81HU
		General	371	371	371
Thermostatic Mixing Valve		15mm – 20mm			
Radiator Valves		Wheel	Angle Pattern	3150	Straight Pattern
		Lockshield		3300LS	
Thermostatic Radiator Valves		Standard	Angle Pattern	3180	Straight Pattern
		Remote		3075/2RS	Straight Pattern

Application	Valve Type	Size Range	Mains Cold Water	Hot & Cold Water Services	Air	Gas (Isolation)
Isolation	Gate	15mm – 50mm	30C	30C	113 Ball	Main Incoming Gas To Building 65mm – 300mm 971/971G (FL Butterfly)
	Butterfly	65mm – 300mm	950W/970W	950W/970W	951/971	
Check	Swing	15mm – 50mm	3047W	3047W		
	In-Line	65mm – 300mm	160W	160W		
Double Check		15mm-50mm		250W/250W		Inside building 15mm – 50mm HNH Fig. 100YL (Ball)
		65mm – 300mm		260W		
Regulating(1)		15mm – 50mm		1432/1432L		
		65mm – 150mm		973W		
Flow Measurement(1)		15mm – 50mm		1000		65mm – 200mm 201M-PN16 (Plug)
		65mm – 300mm		M2000		
Commissioning(1)		15mm – 50mm		1732 M3000		
		65mm – 150mm		973W/M2000/M3000		
Strainers		15mm – 50mm		817		

		65mm – 300mm				
Drains		Plant/Rm		81HU	113	
		General		371		
Thermostatic Mixing Valves		15mm – 20mm		77/78		
Thermal Control Valves (TCV)		½" and ¾"		2900/2910		

(1) Standard, Medium and Low Flow Options Available.
(2) 4990/4993 PN16, PN25, PN40 Steel Butterfly Valves.

4.0 Stopcocks

4.1 A stop cock shall be provided on each branch to an individual draw-off point or on the float serving a range of draw-off points. All stop cocks shall be gun-metal with a crutch handle and conform to BS.1010.

5.0 Altitude Gauges

5.1 All altitude gauges shall be stainless steel cased with 100mm diameter dial. The gauge shall be calibrated in Bars suitably graduated to suit the particular installation with the system working pressure at the mid point, and be fitted with a black indicating pointer and adjustable red pointer for setting at the working head. The gauge connection is to be fitted with an isolating cock.

6.0 Thermometers

6.1 All thermometers shall be stainless steel cased with 100mm diameter dial of the mercury-in-steel type to BS.5235. Gauges shall be calibrated in degrees centigrade and graduated to suit the particular installation with the working temperature at the mid point. Each gauge shall be provided with a copper or stainless steel pocket to permit removal without draining the installation. The Sub-Contractor shall install the pockets in the installation in such a manner as to not obstruct the bore of the pipe whilst avoiding a dead spot.

7.0 Gas Installations

7.1 All gas installations shall generally be in accordance with BS.6891, IGFM/UP/2, IGEM/UP/10 and any specific requirements of the appropriate regional Gas Authority. A clearance of 150mm minimum shall be maintained between gas pipework and electric cables and conduit.

8.0 Domestic Hot and Cold Water Services Generally

8.1 All hot and cold water service installations shall be in accordance with BS8558:2015 and the relevant bye-laws of the local Water Authority. The Sub-Contractor shall comply with any specific requirements of the Water Authority's inspector.

9.0 Sterilisation

9.1 All hot and cold water installations shall be sterilised after completion and immediately prior to handover. Sterilisation shall be carried out to the requirements of BS.8558:2015 by a specialist firm and include cisterns and vessels connected to the system. After sterilisation the mains shall be thoroughly flushed out with clean water. Samples of water shall afterwards be taken and arrangements made by the Sub-Contractor for these to be tested and official certificates to state that the required standard of cleanliness has been attained. The Sub-Contractor shall install a suitable plugged tee in the incoming cold water service adjacent to the main stopcock to facilitate sterilisation and flushing operations.

10.0 Underground Mains

10.1 Underground natural gas and water pipework shall be installed using Medium Density Polyethylene (MDPE) pipe systems designed, manufactured and supplied under a BS EN ISO 9001:2008 accredited Quality Management System. The pipework and associated fittings shall be provided in blue colour for potable water supply below ground and yellow for natural gas supply below ground.

10.2 Excavation and backfilling for underground mains will be carried out by the Main Contractor but the Sub-Contractor shall be responsible for checking the detail of all builders work to ensure a satisfactory installation. Trenches shall be excavated to the required levels and the bottom made firm and level. Where pea gravel is specified then it shall be installed to the correct thickness. Backfilling shall be in layers each layer being consolidated and the surface made level.

10.3 the MDPE mains shall be laid, jointed and pressure tested in accordance with the manufacturers recommendations.

10.4 After installation and before backfilling the mains shall be tested in accordance with the relevant Clauses of the Specification. During testing the Sub-Contractor shall take all necessary precautions against pipe movement by sandbagging etc. The Sub-Contractor shall arrange for the tests to be inspected by the Water or Gas Authority if required, in addition to the Engineer.

10.5 Where pipes pass through the external walls of buildings the Sub-Contractor shall provide a suitable puddle flange or sleeve for building in by the Main Contractor. If a puddle sleeve is provided then the Sub-Contractor shall include for sealing the space between the sleeve and pipe to prevent ingress of water.

10.6 In the case of incoming gas service entry and exit points to buildings the Sub-Contractor shall comply with IGEM standards.

10.7 All steel and copper pipework shall be protected after installation by Denso or equal tape wound as to give a double thickness. Joints only on MDPE shall be similarly protected.

10.8 Where anchor blocks are indicated these will be formed by the Main Contractor, the Sub-Contractor however, shall check that they are adequate to retain pipe movement.

10.9 Polythene water pipes shall not be laid in ground liable to become contaminated with any substance which could cause deterioration of, or permeation of the pipe, nor be laid less than 1 metre from an oil or gas pipe unless suitably protected to prevent permeation. As such all underground potable water pipework and fittings shall be installed using a barrier pipe system

comply with Water Regulations, WRAS complete system approval and be compatible with compression and fusion welded fittings.

10.10 In general water pipes shall not be laid less than 750mm nor more than 1350mm below finished ground level.

11.0 Radiators

11.1 In determining the final position and fixing height of each radiator the Sub-Contractor shall ensure that adequate clearances are left. In general there shall be a minimum clearance of 100mm between finished floor level and the pipe serving a radiator with a further 100mm between pipe and radiator. No radiator or its valves shall project above window sill level.

11.2 The Sub-Contractor shall provide suitable purpose-made brackets for each radiator. For cast-iron radiators building-in brackets shall be provided. For steel radiators the brackets shall be screw-on type.

11.3 Where radiators are fed by a long length of pipe and therefore subject to considerable movement due to expansion then the bracket shall be of the suspended type to allow for this, or some other no less suitable method.

11.4 When fixing to lightweight partitioning where it is impossible to make use of internal timber, then the brackets shall be arranged to carry the weight of the radiator from the floor.

11.5 The Sub-Contractor shall consult with, and collaborate with other Sub-Contractors when fixing radiators to ensure that clashes with electrical equipment are avoided. Any difficulty shall be referred promptly to the Engineer.

11.6 The Sub-Contractor shall include for taking down and refixing all radiators for other trades.

12.0 Tanks and Cisterns

General

12.1 Each tank shall be provided with an overflow pipe run to discharge visibly in accordance with Water Authority requirements. Where this is not possible a warning pipe shall also be fitted. The overflow pipe shall be turned down inside the tank, to terminate 50mm below full water level, and shall terminate externally with a bend looking downwards complete with insect screen. The mains cold water connection to each tank shall be complete with an isolating valve or stopcock and a ball valve. The ball valve shall be fitted in accordance with Water Authority requirements.

12.2 Each tank shall be adequately supported, in the case of sectional tanks by supports under each section joint in one direction. One piece plastics tanks shall be supported over the whole area of the base, in accordance with the manufacturers recommendations. Sectional tanks shall be erected in accordance with the manufacturers recommendations using approved sealing compound between the joints and stainless steel nuts, bolts and washers.

12.3 Galvanised tanks shall be thoroughly cleaned internally after erection and painted in one coat of mordant solution and two coats of approved bitumastic solution.

12.4 Water tanks storing water (hot or cold) for domestic purposes ie. for drinking, cooking, washing and sanitary purposes, shall comply fully with Bye-Law 30 of the Water Supply Bye-Laws.

Plastics Tanks (One Piece)

12.5 Polythene or polypropylene tanks shall comply with BSS.4212 with all connections formed as recommended by the manufacturer and adequately stayed to prevent distortion. Where tanks are to be used for storage of cold water than they shall be suitable for a working temperature of 65ºC, where used as a feed and expansion tank suitable for a temperature of 100°C.

G.R.P Tanks (Sectional)

12.6 Unless otherwise specified G.R.P sectional tanks shall be constructed from 1m x 1m square G.R.P panels externally flanged and internally braced, and assembled in accordance with the manufacturers recommendations.

Overflows

12.7 Overflows shall be run in galvanised steel, copper or plastics pipework to discharge visibly in accordance with Water Authority requirements. Where this is not possible a tell-tale pipe shall also be provided.

12.8 Overflow pipes and tell-tale pipes shall be provided with suitable non-corrodible bird guards securely fixed to the ends of the pipe.

Storage Calorifiers and Cylinders

12.9 Storage calorifiers and cylinder construction shall be in accordance with BS853 for capacities over 450 litres, and BS1566 for capacities below 450 litres. All shall have a body of cold rolled half hard copper with welded seams, the ends shall be copper worked to correct camber and planish hammered before being welded to the body. All joints shall be zinc free. Connections shall be screwed bosses up to and including 50mm, and be flanged stools 65mm and over. The primary heater shall be either an annular heater, a `U' tube battery, or a spiral pipe coil.

12.10 All units shall be provided with the following:-

1 – bolted head or manhole cover.
1 – safety valve
1 – altitude gauge
1 – thermometer
1 – drain cock
1 – thermostat pocket
1 – set primary and secondary flow and return connections

13.0 Thermal Insulation

13.1 Thermal insulation shall be applied to pipework, ductwork, vessels and equipment containing hot or cold fluids in accordance with BS 5422:2009. Insulation shall be applied by a specialist Sub-Contractor in accordance with Current British Standards and Codes of Practice. The Sub-Contractor shall be responsible for the quality of materials and workmanship, also for the provision of any plant and equipment necessary for the proper execution of the Works.

General

13.2 All insulation materials shall be odourless, non-hygroscopic, non-toxic, shall not decompose, support fungal life nor attract vermin or rodent attack. Adhesives shall be non-toxic, non-combustible after drying and shall be compatible with the insulating materials. All phenolic foam and nitrile rubber insulating materials shall have a Class `O' fire rating.

13.3 Thermal insulating materials used within any building shall be free from substances which in the event of a fire would generate appreciable quantities of smoke, noxious or toxic fumes. When requested the evidence of fire classification, obtained from any approved testing laboratory, shall be provided by the Sub-Contractor in order to certify that materials comply with this clause.

13.4 On all cold water services, insulation shall be supplied in accordance with the British Standard Code of Practice covering "Frost Precautions for Water Services".

13.5 Before the application of any insulation the outside surface of the pipe, duct or vessel shall be grease and rust free.

13.6 All service mains and ducts shall be installed, to allow all pipes and ducts to be insulated separately, and all cut ends must be vapour sealed and finished neatly. Adjacent pipework shall not be married together in one common insulation covering.

13.7 No insulation shall be applied to any part of the installation until the Engineer has approved all pipework and tests.

13.8 Particular attention shall be given to the finished appearance of all thermal insulation which shall present a neat symmetrical appearance running twice with pipe layouts etc. Any rough or irregular or badly finished surfaces shall be stripped down and re-insulated to the satisfaction of the Engineer.

13.9 On completion of the installation all plant and equipment shall be cleaned and surplus insulating materials removed from site.

Specific Requirements

13.10 Valves and flanges shall be insulated with material to the same thickness and density as that on the pipework to which they are attached and in accordance with the following:-

(i) On valves and flanges carrying hot and cold fluids in circulation, steam and condense, below 65mm nominal bore no insulation is required. However, where these valves and flanges are exposed within boiler houses or plant rooms they shall be painted two coats black gloss heat resistance paint.

(ii) On <u>all</u> valves and flanges carrying hot and cold fluids in circulation including tank and main cold water services, 65mm nominal bore and above, fix purpose made boxes fabricated from 1.18mm aluminium sheeting lined with preformed insulation. Flange boxes shall be round, hinged in halves with quick release catches for access.

13.11 Pipe bends shall be insulated with preformed material to the same specification as on the pipework. Where moulded shapes are not obtainable segments shall be cut from straight half

sections and mitred to follow the bend in a neat uniform manner. The segments shall be secured to the bend using aluminium banding as specified for the pipework.

13.12 Vapour barriers shall be either in the form of aluminium foil/kraft paper laminate bonded to the insulation material and provided with 50mm of overlap for pasting down over butt joints to maintain the vapour seal. Radial butt joints shall be sealed with matching 50mm wide (Class `O') foil tape. Alternatively, vapour barriers shall be of the polymeric emulsion type, of suitable manufacture, and shall be applied to achieve a sufficient unbroken film thickness. Where it is not possible to achieve a continuous vapour barrier than it shall be returned effectively and sealed to the pipe, duct or vessel surface. Removable items of insulation to access doors, flanged joints, manholes etc, shall be provided with their own vapour barrier overlapping and sealed to the main vapour barrier. The permeance of vapour barriers shall not exceed 0.05 g/s MN.

13.13 Where insulation has a vapour barrier applied, at all points of support the insulation and vapour seal shall be continuous and shall not be pierced or fouled by the supports. The insulation at supports shall be material of sufficient compressive strength to take the loads transmitted to the supports.

13.14 Where the instrument points or tappings are provided on an installation not requiring a vapour barrier the insulation shall be cut away and the edges neatly finished, allowing easy access for the instruments.

13.15 Where external weatherproof insulation is required it should be noted that at pipework supports, both insulation and outer coverings shall be continuous and shall not be punctured by the supports. The insulation at supports shall be material of sufficient density to take the loads transmitted to the supports. The load-bearing insulation shall be extended on each side of the support. At entries into buildings the weatherproofed insulation shall extend not less than 100mm beyond the inner face of the wall and be sealed to the satisfaction of the Engineer.

13.16 At flanges, expansion joints and anchor points, particular attention shall be paid to sealing with insulation against water ingress.

13.17 Care should be taken that on all plant and equipment which has removable covers for maintenance or access or operating purposes, that they are not sealed up by insulation, but have removable insulated mattress or insulated covers of the same integrity as the services to which they are applied.

Insulation Thickness

13.18 Insulation shall conform with the thickness in the following tables depending on type of services, size of services, conductivity and temperatures.

MECHANICAL SERVICES STANDARD AND WORKMANSHIP CLAUSES

Thickness of Insulation for chilled and cold water supplies to prevent condensation and control heat gain on a low emissivity outer finish (0.05) (eg. Bright Class O Foil) in an ambient still air temperature of 25°C and relative humidity of 80%

Steel pipe size (mm)		Temperature of water (°C)					
		+10		+5		0	
		Thickness of insulation (mm)					
NB	OD	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
15	21	15	20	20	25	25	30
20	27	15	20	20	25	25	30
25	34	20	20	25	30	30	35
32	42	20	20	25	30	30	35
40	48	20	25	25	30	30	40
50	60	20	25	25	35	35	40
65	76	20	30	30	35	35	45
80	89	20	30	30	40	40	50
100	114	25	30	35	40	40	50
125	140	25	30	35	45	45	60
150	168	25	35	35	45	45	60
200	219	30	35	40	50	50	60
250	273	30	40	40	50	50	70
300	324	30	40	40	60	55	70
Vessels and flat surfaces		30	50	40	65	50	80

Environmental thickness of insulation for non-domestic heating installations to control heat loss. (Low emissivity 0.05).

Steel pipe size (mm)		Hot face temperature of installation (°C)	
		+100	
		Thickness of insulation (mm)	
NB	OD	Phenolic Foam	Mineral Wool
15	21	15	30
20	27	20	40
25	34	20	45
32	42	20	50
40	48	20	50
50	60	25	60
65	76	25	60
80	89	25	70
100	114	30	70
125		30	70
150	168	30	70
200	219	30	80
250	273	35	80
300	324	35	80
Vessels and flat surfaces		40	65

Environmental thickness of insulation for non-domestic hot water services

Steel pipe size (mm)		Water temperature of 60°C	
		Thickness of insulation (mm)	
NB	OD	Phenolic Foam	Mineral Wool
15	21	15	25
20	27	15	30
25	34	20	30
32	42	20	30
40	48	20	35
50	60	20	35
65	76	25	35
80	89	25	35
100	114	25	40
125		25	40
150	168	25	40
200	219	30	40
250	273	30	45
300	324	30	50
Vessels and flat		35	50

Environmental thickness of insulation for domestic central heating installations (+75°C) and hot water supply systems (60°C) to control heat loss in potentially unheated indoor areas with ambient air temperature of –1°C.

Outside diameter of copper pipe (mm)	Water temperature of 60°C/75°C	
	Thickness of insulation (mm)	
	Phenolic Foam	Mineral Wool
10	15	25
12	15	25
15	15	30
22	20	40
28	20	40
35	25	40
42	25	40
54	25	50
Cylinders	35	50

Environmental thickness of insulation for ductwork carrying warm air only to control heat loss.

Temperature difference between air inside ductwork and ambient air (°C)					
10		25		50	
Environmental thickness of insulation (mm)					
Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
20	40	25	50	35	65

MECHANICAL SERVICES STANDARD AND WORKMANSHIP CLAUSES

Thickness of insulation for condensation and heat gain control on ductwork carrying chilled and dual purpose air in ambient conditions 25°C, – (low emissivity finish 0.05)

Minimum air temperature inside the ductwork (°C)							
15		10		5		0	
Thickness of insulation (mm)							
Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
30	50	35	50	40	70	50	90

Minimum thickness of insulation required to give protection against freezing under specified commercial and institutional conditions

Initial Water temperature		+2°C		+2°C	
Minimum ambient temperature		-6°C (Indoor unheated areas)		-10°C (Outdoor)	
Evaluation period		12h		12h	
Permitted ice formation		50%		50%	
Pipe size (mm)		Thickness of insulation (mm)			
O. Dia	Bore	Phenolic Foam	Mineral Wool	Phenolic Foam	Mineral Wool
Copper Pipes					
15	13,6	35	70	130	320
22	20,2	15	20	30	50
28	26,2	15	20	20	25
35	32,6	15	20	15	20
42	39,6	15	20	15	20
54	51,6	15	20	15	20
76	73,1	15	25	15	25
108	105,0	15	25	15	25
Steel Pipes					
21	15	30	40	75	150
27	20	15	20	30	45
34	25	15	20	20	25
42	32	15	20	15	20
48	40	15	20	15	20
60	50	15	20	15	20
76	65	15	25	15	25
89	80	15	25	15	25

Note: Thicknesses given are minimum calculated specifically against the criteria noted in the table. Adopting these thicknesses may not satisfy other design requirements. Thicknesses shown in brackets are nearest standard thicknesses normally available from manufacturers.

Some of the insulation thicknesses calculated are too large to be applied in practice but are included to highlight the difficulty in protecting small diameter pipes against freezing under extreme conditions. In these cases, to provide the appropriate level of frost protection to certain sizes of pipes, it may be necessary to provide additional heat to the system, for example by controlled periodic circulation of the water or by heat tracing.

Thickness calculations ignore the specific heat capacity and surface resistance of the insulation in order to allow for a common situation where the temperature of the insulation is lower than the initial temperature of the water.

INSULATION TYPES

Material Specification Reference	Service	Temperature Rating	Insulation Type
1.	L.T.H.W M.T.H.W D.H.W.S	230°C max	Rigid, Preformed sections of long fibre resin bonded mineral wool
2.	As above	120°C max	Rigid, preformed sections of phenolic foam
3.	Chilled Water T.C.W M.C.W	Down to 0°C	Rigid, preformed sections of long fibre resin bonded mineral wool incorporating vapour barrier as specified
4.	As above	Down to 0°C	Rigid, preformed sections of phenolic foam incorporating vapour barrier as specified
5.	As above	Down to 0°C	Preformed sections of flexible, closed-cell expanded nitrile rubber elastomeric
6.	Cold vessels and equipment Cold and chilled water storage tanks	Down to 0°C	Rigid slabs of resin bonded long-fibre mineral wool incorporating vapour barrier as specified and secured by 1.0mm dia. galvanised lacing wire and 12.5mm rustless tension bands at 450mm centres.
7.	As above	Down to 0°C	Preformed Phenolic foam slabs incorporating vapour barrier as specified and secured by adhesive, pegs and wiring
8.	Hot vessels and equipment calorifiers condensers hot water storage cylinders etc.	230°C max	Rigid sections of resin bonded long fibre mineral wool secured by 1.0mm dia galvanised lacing wire and 12.5mm rustless tensioning bands at 450mm centres

9.	As above	120°C max	Preformed Phenolic foam slabs secured by adhesive pegs and wiring
10.	Ductwork (Rectangular or circular)	85°C max	Rigid slabs of resin bonded long fibre mineral wool or for circular ductwork flexible mattress, supplied with factory applied reinforced aluminium foil finish at external surface
11.	Ductwork (Rectangular or circular)	85°C max	Preformed Phenolic foam slabs supplied with factory applied Class `O' foil vapour barrier adhered to outer service. The slabs shall be applied so that the top and bottom slabs overlap the side slabs

Insulation Finishes

Polished Aluminium Sheet

Polished aluminium sheeting, cut and fitted to produce a neat, lineable appearance and secured with pop rivets.

The sheet thickness shall be as follows:-

Flat Surface less than 1000mm wide	- 0.9mm
Flat Surface more than 1000mm wide	- 1.2mm
Circular surfaces below 150mm dia	- 0.7mm
Circular surfaces 150-450mm dia	- 0.9mm
Circular surfaces more than 450mm dia	- 1.2mm

Care shall be taken to avoid damage to any vapour barrier when fixing.

Hammered Aluminium Sheet

As above but using hammer finish aluminium sheet.

Rigid P.V.C sheeting

Rigid PVC sheeting fitted in accordance with the manufacturers instructions and secured with plastic rivets. Purpose-manufactured fittings shall be used at bends, tees and elbows and exposed ends covered with metal cappings. Any vapour barrier shall be maintained.

Polyisobutyline (P.I.B) sheeting

P.I.B sheeting shall be applied in accordance with the manufacturers instructions using the recommended solvent. Where used for weatherproofing 0.8mm thickness sheeting shall be used. For a vapour barrier 1.0mm thickness is required. The permeance of the barrier shall

not exceed 0.5g/s MN.

Bends, tees and elbows shall be covered with P.I.B sheeting cut to shape, so as to provide an overlap of at least 25mm. The ends of the insulation and points where the sheeting is penetrated shall be sealed with an approved sealer/adhesive.

Canvas and Bands

Insulation shall be finished with cotton canvas not less than 200g/m² and coated with a fire resistant adhesive/coating, such as Kooltherm CP50, or equal and approved.

Felt and Wire Netting

Insulation shall be covered with two-ply waterproof felt with a minimum of 50mm overlap sealed with bituminous adhesive. The whole shall be covered with 25mm galvanised wire netting to BS.1485 secured with lacing wires, and finally painted with two coats of black bituminous paint.

Aluminium Foil

The insulation shall be finished with factory applied Class `O' reinforced aluminium foil with a 50mm overlap along the longitudinal opening joint. Radial joints between sections shall be sealed with a band of 50mm wide matching Class `O' foil tape.

The adhesive shall be as recommended by the manufacturer.

Identification of Insulation

13.19 Identification bands of plasticised PVC self adhesive type to BS4800 shall be used on services.

13.20 All services within the boiler houses and plant rooms to have an identification colour applied by one of the following methods.

13. As a colour band, 150mm wide. The band to be applied at termination points, junctions, entry and exit of walls and ducts, control points and any other position specified.

b. On large diameter pipelines, vessels, cylinders, calorifiers etc, colour panels are to be applied in similar positions to (a) above.

13.21 The Code indicators that are to be applied in boiler houses and plant rooms, to all services, shall be in accordance with the following. Colour code bands are to be applied in widths of 100mm, between 150mm basic identification colour bands or at strategic positions when the whole length of the pipeline is the basic colour as (a) above. Lettering and symbols shall be used to designate the service and direction of flow of the fluid and these must be applied in black or white as a contrast to the basic identification colour. Any lettering shall be clearly legible.

14.0 Removal of Existing Asbestos Insulation

14.1 Where a project requires the removal of insulation containing asbestos then the requirements of the Asbestos Regulations 1969 and Sections 2, 3, 4 and 7 of the Health and Safety at Work Act 1974 shall be observed. The work shall be carried out only by a specialist firm of Sub-

Contractors chosen from the latest Health and Safety Executives approved list, or as named in the specification. The Sub-Contractor shall be responsible for programming this work to avoid delaying the Contract including giving statutory notice, carrying out air tests and obtaining clearance certificates.

15.0 Electrolytic Action

15.1 Where dissimilar metals join a suitable plastic or some other not less effective insulating fitting shall be used in order to prevent electrolytic action.

16.0 Draining Down, Filling and Venting

16.1 The Sub-Contractor shall include for draining down, filling and venting of the new and/or existing systems as many times as is necessary to carry out, test and commission the works.

17.0 Flushing Out

17.1 After completion and testing of water systems, the whole installation shall be drained down, flushed through and refilled. In the case of closed systems, a proprietary corrosion inhibitor shall be added during refilling, in the concentration recommended by the manufacturer.

17.2 Steam or gas systems shall be blown through by steam or compressed air, after which all strainers and dirt pockets shall be opened and cleaned out.

18.0 Regulation

18.1 The Sub-Contractor shall regulate and balance all circuits to ensure an even flow through the systems. Existing systems which have been extended shall be re-regulated if necessary.

18.2 If flow measurement or commissioning valves are specified for a project then the Sub-Contractor shall supply a tabulated summary of the measured flow rates for each circuit to the Engineer, and additional copies shall be included in the operating and maintenance instructions.

19.0 Final Connections to Draw-Off Points

19.1 A stop cock shall be provided on each branch to an individual draw-off point or on the float serving a range of fittings. Unless otherwise specified later, all final connections to draw off points shall be carried out by the Sub-Contractor. All necessary tap connectors, swivels etc, shall be included.

20.0 Automatic Flushing Device

20.1 Where tank or mains cold water services are connected to a urinal cistern then a mechanical automatic flushing valve shall be fitted of a type that does not permit passage of water at times when the building is unoccupied.

21.0 Noise and Vibration

21.1 Fans, compressors, pumps, motors and any other vibration producing equipment shall be

isolated from the building structure by anti-vibration mountings which shall be compressed cork, spring or rubber dampers, or rubber/metal mountings as indicated. Where cork is used the Sub-Contractor shall be responsible for its correct positioning within the concrete base, all other anti-vibration mountings shall be supplied and fixed by the Sub-Contractor. The Sub-Contractor shall also ensure that vibration likely to be transferred to the structure by pipe or ductwork support is isolated.

21.2 Noise level data based on octave band analysis shall be forwarded to the Engineer, in the case of air handling unit fans to enable a check to be carried out on the attenuator.

22.0 Painting

22.1 All unpolished or ungalvanised iron or steel is to receive a coat of protective paint or vanish prior to delivery to site and the Sub-Contractor shall maintain this until the work is finally painted or lagged.

22.2 During the course of installation any ferrous work showing signs of rusting shall be thoroughly wire brushed and painted with rust inhibiting primer to BS2523. All welded joints shall be similarly treated. After erection all ferrous brackets and support systems shall receive a further coat of primer.

22.3 The Sub-Contractor shall include for painting all uninsulated metalwork in boiler houses and plant rooms, such as exposed flanges, brackets, pump casings, valve bodies etc, with two coats of heat resisting enamel to an approved colour.

22.4 All galvanised water tanks are to be painted internally after erection with one coat of mordant solution and two coats of bitumastic solution.

23.0 Protection of Equipment, Cleaning and Polishing

23.1 During the whole of the Contract the Sub-Contractor shall maintain all plant, materials and equipment in a clean and workmanlike manner.

23.2 All plant items, stove enamelled sheet steel, polished work etc, shall be protected against damp and condensation by oiling or spraying with a moisture repellent compound, and further protected if necessary by polythene sheeting. Before handover the Sub-Contractor shall clean down and polish all stove enamelled work, polished work, brass, gauges etc, to the satisfaction of the Engineer. Any items of minor damage shall be made good.

23.3 The Sub-Contractor shall take all reasonable precautions to protect items of plant from accidental damage.

23.4 The Engineer reserves the right to condemn any items of plant or equipment that has suffered major damage or deterioration due to non-compliance with the above.

24.0 Ductwork

General

24.1 Ductwork construction installation and testing shall be generally undertaken in compliance with the following BESA/HVCA standard documents:

DW/144	Specification for sheet metal ductwork, low, medium and high pressure/velocity air systems.
DW/143	A Practical Guide to Ductwork Leakage Testing.
DW/172	Specification for kitchen ventilation systems.
TR/19	Guide to Good Practice – Cleanliness of Ventilation Systems.

24.2 The Sub-Contractor shall include for the supply and delivery and erection of the ranges of ductwork as shown on the drawings. Whilst the ductwork systems have been shown as accurately as possible on the drawings the Sub-Contractor/Specialist shall be responsible for producing his own manufacturing/installation drawings from site dimensions which shall be submitted to the Engineer for approval before manufacture commences. These drawings shall take into account all relevant information including architectural, structural and suspended ceiling details, as well as other services.

24.3 In respect of the manufacturing/installation drawings the Sub-Contractor shall be responsible for ensuring that the ductwork systems fit into the spaces allowed for them without clashing with other services or structures. Any major difficulties shall be referred to the Engineer early in the course of production of the drawings. Final grille and diffuser positions shall be obtained from and confirmed with the ceiling Sub-Contractor.

Ductwork Construction Generally

24.4 No claim for additional cost will be allowed by the Engineer due to failure to comply with the above.

24.5 In general all ductwork shall be installed truly horizontally and vertically and be adequately supported from the building structure avoiding any undue strain, sagging or vibration.

24.6 All ductwork shall be truly square, rectangular or circular as appropriate, any deformed or twisted ductwork will not be accepted and shall be replaced as directed by the Engineer.

24.7 The pressure classification of ductwork systems shall be as required to suit the total pressure on the system and shall be constructed to comply with the air leakage limits list in DW144.

24.8 All ductwork shall be constructed so as to be capable of withstanding the system pressure, whether positive or negative without distortion or deformation. All ductwork shall be adequately braced and stiffened to prevent drumming and vibration.

24.9 All ductwork dimensions as indicated on the drawings are internal dimensions hence no joints that reduce the internal area will be allowed. No projection of metal, jointing or any other obstruction shall be allowed in the airstream. All slip joints shall be in the same direction as the air flow.

24.10 Setting out of ductwork shall be carried out with a view to minimising the number of changes of direction or shape and every effort shall be made to avoid increasing resistance to air flow or creating localised high velocity or excessive turbulence.

24.11 Connections to grilles or diffusers shall be in accordance with the grilles or diffuser manufacturer's recommendations regarding air approach, neck length, equalising control and

volume control. The duct serving a supply grille or diffuser, where no plenum box is provided, shall be extended to form a cushion head.

24.12 Where connection are made to fan coils, these shall be in accordance with the manufacturer's guidelines, but with a maximum flexible connection of 500mm. Where flexible ductwork connections are not possible, ductwork is to be terminated no more than 100mm from the return air path of the fan coil unit. The duct serving the fan coil unit should be sized to suit the supply air rate, with minimal velocity and noise in mind.

Ductwork Construction Details

24.13 Construction shall be in accordance with the recommendations contained within BESA/HVCA specification no. DW/144. Unless specified otherwise all ductwork shall be formed from strip mill cold reduced, continuously hot dipped galvanised mild steel sheet to BS EN 10142.

24.14 Round bends shall have a mid-line radius to width ratio of not less than 1.5. Where this is not possible then square bends shall be used incorporating aerofoil turning vanes. All duct transformation pieces etc, shall be constructed with an included angle not greater than 30^{o} and offset not more than 15^{o}. Where this is not possible vanes must be employed. Junctions shall be so formed that the ducting is enlarged in such a manner as to maintain an equivalent velocity in the main and branch duct at the point of junction. Branch bends shall be purpose made fittings.

24.15 Except at fire compartments where fire dampers will be provided, where ducts pass through or terminate at walls or floors the holes left in the structure will be provided with timber frames (under a separate contract). Mild steel angle flanges shall be provided fixed to both the duct and frame.

24.16 Where wall or floor mounted grilles are provided then the duct shall be continued through the timber frame to connect to the grille.

24.17 All mild steel sections used in the fabrication of sheet metal ducting shall be free from rust and painted one coat of red oxide or chromate primer at the manufacturers works and one further coat on site to erection. This shall also apply to black mild steel ductwork where used.

24.18 Where ductwork is to be mounted externally without weatherproof insulation then galvanised steel ductwork shall be painted one coat of mordant solution following by two coats of bituminous paint.

24.19 No site welding shall be permitted on galvanised components except by permission of the Engineer. Any weld so authorised shall be wire brushed on both surfaces to remove deposits and painted with two coats of zinc based paint.

24.20 The Sub-Contractor shall ensure that during erection any open ends of ductwork, grilles or diffusers are protected from the ingress of dirt or rubbish reinforced cardboard or plastic covers securely held in place by adhesive tape. The Engineer reserves the right to have any section of ductwork removed or cleaned should these precautions not be observed.

24.21 Where a duct passes through a fire barrier a fire damper with adjacent access door shall be provided. The Sub-Contractor shall ensure that the duct and damper are effectively fire sealed.

Sealants and Jointing

24.22 Joints and seams shall be made with a sealer during manufacture and in erection and every effort made to reduce air leakage to a minimum, without requiring additional tape or similar. The sealer shall be applied to lock formed joints and seams during manufacture.

24.23 Materials associated with ductwork construction or erection, such as plastics synthetic materials, etc used for gaskets or sealing shall be unaffected by other solvents or sealants and shall not deteriorate under the effects of time, temperature, light or humidity. They shall comply with the Local Authority and Fire Officer's requirements.

24.24 Sealers shall be applied strictly in accordance with the manufacturer's recommendations including particular reference to cleanliness and setting times. Care must be taken to ensure that the sealant has not deteriorated or hardened before use.

24.25 Sealants shall be of the liquid/mastic type which permanently retain adhesive and elasticity throughout a temperature range 0°-70°C. The sealant may be applied by either brush or gun and must completely seal the joint. Before application of any sealant all surfaces shall be cleaned and degreased. Sealant shall be applied during the formation of longitudinal lock seams, and prior to the joint being made in the case of slip joints. The ductwork systems shall not be pressurised until the sealant has cured.

24.26 Angle flange joints shall be joined using a suitable gasket. Gaskets shall not be less than 3mm thick for ducts of up to 1mm sheet thickness, not less than 4mm thick for ducts of up to 1.2mm sheet thickness.

Ductwork Supports

24.27 The Sub-Contractor/Specialist shall provide and install a complete bracketing system to adequately support the ductwork systems from the building structure. This shall include the attachments to the building structure, the primary steel supports, the drop rods and hangers and the duct supporting steel.

24.28 The Sub-Contractor/Specialist shall detail his proposals for ductwork supports on his manufacturing/installation drawings and these shall be submitted to the Engineer and Structural Engineer for comment. In the case of ceiling voids where there are a multiplicity of services then the Sub-Contractor shall arrange his support system to take account of these other services and shall produce a uniform coherent system of bracketing in co-operation with other trades. Where it is necessary to support other services below ductwork then account shall be taken of this in the design of the duct supports.

24.29 Uninsulated ductwork shall have anti-vibration strips inserted between the duct and support to reduce noise/vibration transmission. Insulated ductwork shall have a length of load bearing insulation block inserted into the support to provide thermal insulation and keep the support on the outside of the insulation.

24.30 In the case of rectangular ductwork an additional length of mild steel angle shall be provided on top of the duct if it is necessary to secure the duct firmly on the lower support.

24.31 All black mild steel components used in supporting systems shall receive one coat of red oxide or zinc chromate primer prior to delivery to site and a further coat prior to erection.

Access Doors

24.32 Airtight access doors shall be provided for inspection, cleaning and maintenance purposes in accordance with TR/19 Tables 2, 3 and 4. Access doors shall therefore be provided at the following points:-

Control Dampers	Both Sides
Fire Dampers	Both Sides
Heating/Cooling Coils	Both Sides
Attenuators (Rectangular)	Both Sides
Attenuators (Circular)	One Side
Fitter Sections	Both Sides
Air Turning Vanes	Both Sides
Changes of Direction	One Side
In Duct Fans/Devices	Both Sides

24.33 Access doors on insulated ducts shall be of double sheet steel constructed with insulation sandwiched between. Door frames shall be of sufficient thickness so that the door is flush with the duct insulation which shall be retained by a return frame. Proprietary doors shall be approved by the Engineers.

Test Holes for Commissioning

24.34 Test holes shall be provided on all main supply and return air ducts and on all major branches as necessary to commission the plant. A major branch shall be considered to be one carrying an air volume equal to or greater than 20% of the main plant duty. Test holes shall be 25mm dia in an accessible position, on a straight section of duct not less than 7 x duct width or diameter clear of any band, fitting or item of plant. Where such a location is not possible, the position of the test holes shall be subject to approval. At completion test holes shall be sealed with rubber grommets.

Flexible Connections

24.35 Flexible connections shall be fitted at all fans and vibration producing equipment and shall be as short as possible above a minimum length of 100mm and shall not exceed 200mm. On circular spigots and ductwork the flexible connections shall be secured by a clipped adjustable screw band. On rectangular sections the connection is to be held in place by a mating flange and backing plate. Material used for flexible connections shall be capable of withstanding all conditions of pressure and temperature encountered in the system and possess fire resistant and acoustic properties.

24.36 Flexible connections shall be considered as part of the ductwork system when considering leakage rates. They shall be made from a non-combustible rot proof Class O rated material, to Local Authority and Fire Officer's approval. They shall be quality and grade to suit the temperatures, velocities and pressure involved without permitting perceptible air leakage or noise breakout. Where connections are fitted between the noise source and attenuator they shall be acoustically treated to prevent breakout.

24.37 Flexible connections shall be fitted free from stress and not be required to support any weight. On rectangular ductwork section, the material shall be securely fixed to a frame, not secured by straps.

24.38 An earthing strap shall be fitted across each flexible connection to provide electrical bonding. This shall be arranged to avoid fracture or vibration leading to fracture.

Flexible Ductwork

24.39 Flexible ductwork shall only be used where indicated for final connection to terminal devises.

24.40 Material shall be suitable for the working temperature and pressure of the system and shall be tear resistant. The ductwork shall comply with the standards of air tightness required by DW144. The ductwork services installer shall obtain written approval from the Local Authority and the Fire brigade for the type of flexible ductwork proposed.

24.41 Flexible ductwork shall have a fabric liner inside a galvanised wire helix reinforced with an outer helix of glass fibre cord all suitable covered. On supply air systems it shall be pre-insulted.

24.42 Flexible ductwork shall comply with fire test requirements of BS 476: Part 6, for a fire propagation index of performance not exceeding 12 of which not more than 6 should derive from the initial period of the test. It shall also comply with BS 476: Part 7: Class 1 spread of flame and BS 476: Part 20 fire resistance of 15 minutes minimum.

24.43 Flexible ductwork may only be used in individual lengths not exceeding 500mm. It shall resist deformation during erection and shall be a true circular cross section when offered for completion. It shall not bend at any angle above 45^{o}.

Dampers

24.44 Dampers shall be provided where required to effectively balance the systems without the generation of undue noise. All dampers shall be fitted in accessible positions. All dampers shall be of the multi-blade type, parallel blade or opposed blade as indicated.

24.45 Motor operated dampers shall have face dimensions complying with the duct size. Where dampers are smaller than the duct size then blanking plates shall be provided unless convergent/divergent duct sections are shown on the drawings.

24.46 Manually operated dampers shall be full duct size unless otherwise indicated. Angle flange lateral joints shall be provided on the ducts for the operation of dampers. Damper frames shall be drilled to suit bolt holes in the angle flanges.

24.47 All dampers shall be suitable for operating against the system pressures and velocities without undue noise or vibration.

Damper Frames

24.48 Damper frames shall be constructed from not less than 1.6mm thickness galvanised sheet steel folded to channel sections not less than 150mm wide. Frames shall be welded at the corners and then painted with zinc rich paint. Mullions shall be constructed from not less than 1.6mm thickness galvanised sheet steel folded and rivetted into a box section.

Damper Blades

24.49 Damper blades shall be constructed from 1.6mm thick galvanised sheet steel or stainless steel. Blades shall not be more than 250mm deep nor more than 750mm long between supports.

Neoprene rubber sealing strip shall be fitted to blades to prevent air leakage.

Bearings and Spindles

24.50 Where dampers are to be motorised or used in systems having a static pressure greater than 500pa, ball bearings only shall be used in housings rivetted to damper side frames. Otherwise bearing shall be sintered bronze.

24.51 Spindles shall not be less than 10mm diameter and made from cadmium plated steel. The spindles shall be continuous over the entire width of the blade and securely fixed to the blade.

Linkage

24.52 Dampers shall be linked with tie bars and links arranged to give parrel or contra-rotation action as necessary. Tie bars and links shall be manufactured from cadmium plated steel drilled before plating. Linkpins shall be brass and shall be secured by circlips. There shall be no perceptible play in any linkage system. Where two sets of dampers are operated from one motor each linkage shall be capable of independent adjustment. Linkage used with manually operated dampers shall incorporate means of positioning, locking and indicating the position of the damper.

Volume Control Dampers

24.53 Volume control dampers shall be provided to enable the system to be effectively balanced and regulated without the generation of undue noise.

24.54 Dampers shall be constructed to comply with the requirements of DW144 and to the requirements of this clause. They shall be constructed to sheet metal compatible with the duct material. The following damper types shall be used:

1. On circular cross-sectional ductwork – iris dampers or double skin, streamlined butterfly dampers.

2. On rectangular section ductwork – opposed blade type with double skin aerofoil section blades.

24.55 Dampers shall be located in the following position whether indicated on the drawings or not:

1. The discharge of each fan connected to a ductwork system.
2. Each main supply and extract branch duct.
3. Each supply and extract branch having three or more terminals.
4. Each air terminal grille or diffusers.
5. Fresh air intake and exhaust air ducts – motorised open-shut.

24.56 Dampers shall be located to enable easy installation, regulation and maintenance. They shall be provided with a free area when the damper is fully open of not less than:

- $0.2m^2$ 60%
- $1.0m^2$ 75%
- $5.0m^2$ 80%

24.57 Isolating only dampers shall be low leakage type with seals on the tips and jambs of the blades.

Air bypass leakage shall be limited to five percent of the maximum design airflow when the damper is in the fully closed position.

24.58 Surfaces shall be smooth to reduce noise generation and any internal linkage arranged to minimised noise.

24.59 Manual adjustment shall be from outside the duct and suitable locking devices fitted. Dampers shall be fitted with position indicators and the final setting permanently marked.

24.60 Where required dampers shall be motorised to provide isolation facilities.

Motorised Dampers

24.61 Motorised dampers shall be installed within substantial galvanised mild steel frames to ensure adequate support with true and positive alignment. Each damper section shall be independently supported with its own frame. Adjacent frames shall be bolted or welded together to form an integral structural element.

24.62 Blades shall be formed from stainless steel at least 1.6mm thick with maximum dimensions of 200mm wide and 1200mm long. They shall be formed into a streamlined section or rigid construction.

24.63 Dampers shall be provided with solid stops; blades shall have edge and tip seals. Closed damper leakage shall not exceed 2% of full flow with a differential pressure of 1000Pa across the face.

24.64 Variable fresh air, intake, exhaust and recirculation dampers shall be of the high pressure, low leakage, opposed blade type. Minimum fresh air, exhaust and fan discharge dampers shall be of the parallel blade type.

Fire Dampers

24.65 Fire dampers shall be fitted wherever ducts pass through fire walls, ceilings, floors, smoke barriers or whether required by the fire strategy. All fire dampers shall be fusible link operated.

24.66 They shall be built into a fire barrier with installation frames, adequately fire stopped and sealed to maintain the integrity and stability for at least the required fire period. Access doors shall be provided for resetting and inspection. Special care shall be taken to avoid noise or turbulence generated by fire dampers.

24.67 Interlocking blade shutter type dampers shall have blades positioned outside the main air stream in the open position unless otherwise agreed. Dampers in horizontal ducts shall be fitted so that they close vertically downwards.

24.68 Fusible links shall be selected to support blades or curtains in the open position and release them at 72^{o}C operating temperature unless stated otherwise. Operation of the fusible link shall cause the damper to close and seal the duct. External blade position indicators shall be fitted to each damper.

24.69 Upon completion of the installation but prior to handover, ALL dampers will be tested for operation. A schedule with test dates and completion signatures will be provided within the operation and maintenance manuals.

25.0 Electrical Work

25.1 Where a project requires electrical works to be carried out under this Sub-Contract, the work shall be carried out only by a competent electrician. With regard to equipment the Sub-Contractor is supplying, full electrical details shall be forwarded to the Engineer at an early stage in the Contract. This shall include all motor ratings, staring and running currents, fuse ratings, wiring and connection diagrams and full wiring details of any control equipment.

26.0 Control Panels

26.1 The following minimum standards shall apply:-

Chassis

This shall be manufactured from 2mm thick mild steel sheet folded and welded construction, dust proof and drip proof. The size of the panel shall be adequate for the equipment contained.

Doors

This shall be manufactured from 2mm thick mild steel sheet, folded and welded, having mild steel stiffening if necessary.

Finish

This shall be grey enamel inside and outside, unless otherwise specified.

External Layout

26.2 The location of all lamps switches and labels shall be approved by the Engineer but shall be generally as follows.

An amber `panel live'.

A pair of green `run' and red `tripped' lamps for each motor.

A red `control circuit fuse failed' lamp.

All lamps shall be of the transformer type.

All motor control switches shall be of the heavy duty rotary type.

All lamps and switches shall be provided with an engraved identification label, identification label terminology shall be approved by the Engineer.

Internal Layout

26.3 The main incoming electrical supply shall be wired directly to an isolator, mechanically interlocked with the door handle. No other method shall be used. Live connections on the supply side of the isolator shall be shrouded and a warning label fitted. Cables are to be individually numbered at a terminal strip, the numbers relating to the panel wiring. Equipment mounted within the panel shall be clearly and uniquely labelled. A pocket shall be fixed to the

inside of the panel door for the storage of wiring diagrams. All automatic control equipment fitted within the panel shall be of one manufacturer in conformity with the external control equipment.

Commissioning

26.4 The Sub-Contractor shall include for the control panel manufacturer to commission the control panel.

27.0 Automatic Controls

27.1 Where a project requires automatic controls then these shall be supplied and commissioned by a specialist control supplier.

27.2 The detailed specification for the automatic controls is identified in the specified requirement of the specification, however the following minimum standards shall apply:-

27.3 All items of control equipment including panels, valves, actuators, pipe or duct detectors, flow switches etc, shall be fitted by the Sub-Contractor in the positions shown on the drawings or subsequently agreed with the Engineer and controls specialist.

27.4 The Sub-Contractor shall be solely responsible for the liaison with the control specialist in determining recommended location of all controls items prior to obtaining the approval of the Engineer.

27.5 The Sub-Contractor shall obtain the control specialist wiring diagrams and submit these to the Engineer for comment before manufacture commences. These shall detail both panel internal wiring and external controls wiring.

27.6 Except where stated elsewhere all motorised valves shall be of the three port modulating type suitably sized by the controls specialist to give the correct authority.

27.7 All valves shall be complete with the necessary actuator and linkages.

27.8 The Sub-Contractor shall include for reducing the pipework at valve positions as necessary and for any special counterflanges. All isolating valves shall be line size.

27.9 Immersion detectors shall be provided with a stainless steel or copper pocket fitted into the pipe or vessel. The Sub-Contractor shall ensure that the position is suitable for meaningful temperature detectors, whilst not obstructing fluid flow.

27.10 Thermostats or detectors which are readily accessible in occupied areas shall be tamper proof.

27.11 Timeswitches shall be driven by a synchronous motor with a quartz reserve.

27.12 All automatic control equipment used on the project shall be of one manufacture.

27.13 The Sub-Contractor shall include for the manufacturers to commission the automatic control installation.

28.0 Testing Procedures

28.1 All sections of the installation are to be tested after installation and test reports submitted to the Engineer stating that the requirements of the detail specification stated later in this document have been met. This applies to testing of pipework, boiler and other plant, manufacturers tests and also information to satisfactory circulation, temperatures pressures, air flows etc.

28.2 The Sub-Contractor shall allow sufficient time in his installation programme for all testing and commissioning procedures.

28.3 Testing shall be carried out in stages if necessary due to the progress of the works and all necessary blanking off, filling up or draining down included.

28.4 If any item of plant has a test pressure lower than that specified for the installation then the Sub-Contractor shall disconnect and blank off.

28.5 The Sub-Contractor shall, if required, provide evidence of correct calibration of all instruments used in connection with testing.

28.6 All pressure testing shall be carried out prior to the application of thermal insulation and is to be witnessed by the Engineer or his representative. The Sub-Contractor shall carry out his own preliminary testing before requesting the presence of the Engineer to witness the final tests. At least three days written notice shall be given of intention to carry out final testing.

a. Hydraulic Tests: are to be carried out prior to application of thermal insulation, and shall be to pressures and of a duration stated in detail later in this specification. Test pumps shall be disconnected during the testing.

b. Boiler Plant: shall be tested after commissioning and a written report submitted stating efficiency, CO_2 percentage, flue gas temperatures, particulars relating to fuel consumption and any other remarks advising upon condition noted during tests.

c. Air Tests: are to be carried out in instances stated later. These shall be similar to above.

d. Ventilation/Air Handling System: shall be tested in accordance with D.W. 142 and set in operation and regulated to give the air volumes/temperatures stated by the Engineer as the design criteria. The plant shall be checked for correct running and elimination of all vibration and noise.

e. Items of Plant: requiring testing by manufacturer shall be supplied with label suitably engraved stating pressure, time and manufacturers stamp, together with any relevant Code of Practice references. Certificates stating these details shall also be provided if so requested.

f. Items of Plant: incorporating moving parts e.g. pumps, fans, motors etc., shall all be checked for quiet and efficient running, shall be vibration-free and shall be left correctly oiled/greased and ready for immediate use by the operator.

Generally all welded vessels and pipes shall be subjected to test pressure 1.5 times the Design Pressure.

g. Refrigeration: all the various refrigeration machines and associated plant shall be commissioned in strict accordance with Commissioning Codes. All the test connections, drain cocks etc., needed to carry out this commissioning shall be included in the costs.

h. Heating Systems: on heating systems where flow measurement valves have been fitted then the Sub-Contractor shall regulate all circuits to achieve the design flow rates. These will be provided by the Engineer.

28.7 Services are to be tested to the following pressures unless specified elsewhere:-

i. Low Temperature Hot Water Heating: the whole of the installation shall be subjected to a hydraulic test pressure of 690kPa.

ii. Domestic Hot Water Service: the whole of the installation shall be subject to a hydraulic test pressure of 520kPa.

iii. Tank Cold Water Service: the whole of the installation shall be subject to a hydraulic test pressure of 520kPa.

iv. Mains Cold Water Service (Internal): the whole of the installation shall be subjected to a hydraulic test pressure of 1040kPa.

v. Cold Water Mains (External): the whole of the installation shall be subjected to a hydraulic test pressure of 1040kPa.

vi. The above test pressures shall be maintained for a period of two hours or as specified with the pumps disconnected during which time all materials, connections and joints shall remain tight and dry. Any leakage or defects disclosed by the tests shall be made good and a further test or tests made until all services are tight and dry.

On completion of the above tests all mains are to be thoroughly flushed out to remove all foreign matter refilled and where applicable circulation and heat tests applied.

vii. Gas. The installation shall be strength tested, tightness tested and purge tested in accordance with

IGE/UP/1 for systems over 21m bar pressure
IGE/UP/1A for systems under 21m bar pressure

viii. Ductwork: at the discretion of the Engineer three sections of ductwork will be subject to an air leakage test performed in accordance with DW142 and the Sub-Contractor shall allow in his tender for all necessary blanking pieces, test fan and equipment and attendance necessary for the test.

The air leakage rate for any section shall not be in excess of the permitted rate for that section. In the event of a test producing a leakage rate in excess of the permitted maximum, the section shall be re-sealed and re-tested until a satisfactory leakage rate is achieved. If an air test proves not to be satisfactory the Engineer reserves the right to have one further section of the ductwork tested per failed test section.

28.8 At the conclusion of the test certificate shall be issued to the Engineer.

29.0 Commissioning

29.1 The Sub-Contractor shall include for all systems and specialist equipment to be commissioned by the relevant manufacturer. All commissioning reports shall be forwarded to the Engineer and further copies included in the operating and maintenance manuals.

30.0 Operation of Plant Prior to Completion

30.1 Except for the purposes of commissioning and testing the plant shall not be operated before handover, unless an official order in writing is received from the Employer. Such operation shall not relieve the Sub-Contractor of the responsibility of handing over the installation in good condition on the date of practical completion.

31.0 Valve Chart and Labels

31.1 The Sub-Contractor shall provide and fix in the boiler house plant rooms a chart indicating the duty of all valves. The chart shall be framed and glazed. Brass or ivorine labels with letters engraved, corresponding to the chart shall be securely fitted to each valve, screwed or bolted to the spindle top wherever possible.

32.0 Name Plates

32.1 Manufacturers name plates clearly and permanently marked with dates, duties etc., shall be provided on all pumps, fans, motors, boilers, calorifiers and other major plant items. If the Sub-Contractor desires to use his own name plate then permission must be sought from the Engineer.

33.0 Unspecified Design Work

33.1 The Sub-Contractor shall be responsible for the correct selection and/or design of any items, brackets, supports etc., which are required for the successful completion of the works but which have not been specified or detailed upon the drawings, subject to the approval, in principle, of the Engineer. He shall ensure that all such items selected are suitable for the intended use and comply fully with the specification.

34.0 Refrigeration Pipework

General

34.1 Refrigeration pipework shall be designed and installed such that oil in the refrigerant leaving the compressor (and passing through any oil separator fitted) shall be carried through the system and back to the compressor oil reservoir or sump at the lowest stage of capacity unloading. All work shall be carried out by a certified CFC handler.

Pipework

34.2 All pipework shall be refrigeration quality copper pipe to BS 2871 Part 2. Straight lengths half hard shall have a wall thickness of 18 SWG up to 54mm OD and 16 SWG above 54mm OD.

34.3 Fully annealed pipework shall only be used up to and including 20mm OD and shall have a wall thickness of 20 SWG.

Joints

34.4 Joints shall be flared (up to 20mm only) or bronze welded.

34.5 Bronze welding shall be carried out in accordance with the requirements of BS 1724 using capillary fittings to BS 864 Part 2 or Eutectic Solder (Eutec 157 or equal and approved by the S.O.)

Bronze and Soldered

34.6 Due to the increased resistance to pressure, temperature and vibrational stresses, for gas tightness, brazing is preferable to soldering. The possibility of corrosion should be considered.

Shut-Off Devices (Valves, Cocks, Gate Valves)

34.7 These devices shall accord with pertinent rules. Facilities for convenient access shall be provided. It shall be possible to tighten or to remove gland packing while under pressure. Unintentional turning out of valve spindles and/or covers shall be prevented.

34.8 The design of capped valves shall be such that refrigerant under pressure that might be present under the cap shall be vented rapidly when starting to remove the cap, e.g by a drilled hole uncovered by the first turn of the cap.

Arrangement of Shut Off Devices

34.9 To minimise danger and loss of refrigerant, machines and apparatus shall be equipped, as appropriate, with isolating valves either individually, or in groups.

34.10 Those valves shall have hand wheels for immediate operation or be of a quick acting type e.g. fail safe solenoid valves.

Draining Refrigerants and Oil

34.11 Facilities for emptying shall be provided on machines and apparatus. For draining oil, in addition to a shut of valve with handwheel, a rapid closing valve with spring or weight loading may be used. If the plant contains noxious refrigerant in excess of 45kg (100lb) in weight this safeguard shall become mandatory.

Marking

34.12 It is recommended that all shut-off devices should be identified for example with a number.

Installation

34.13 On installation of all sizes and types where welding or brazing take place nitrogen shall be passed through the pipework at a velocity to displace the air within the tube and prevent oxides forming.

34.14 Refrigerant circuits shall be suitable supported. After each length of tube is cut and made ready its shall be cleaned before installing the system.

34.15 Piping and other components which have been prepared and are not to be used immediately shall be capped and sealed. During installation no component or length of tubing shall be left unblanked longer than necessary for installation.

34.16 Refrigerant circuits shall be supported by independent purpose made support brackets. The distance between the supports depends on the size and service weight of the pipeline. The clearance around pipelines shall be sufficient to allow any attention to fittings, etc. free passage should not be obstructed.

34.17 Pipes passing through fire resisting walls and ceiling shall be so sealed as not to allow spreading of fire to neighbouring rooms. Pipe ducts and shafts shall be shut off from other rooms in such a way as to resist the spread of fire.

34.18 Long runs for pipeline shall have provision for expansion. Flexible hoses, for example those used in plate freezers, shall be well protected against any possibility if mechanical damage.

34.19 Pipelines, valves and fittings, particularly if less than 2m above the floor, shall be adequately guarded.

34.20 Overhead pipes should be fixed as high as practicable. In channels or ducts for refrigeration piping there shall not be other pipelines nor electric wires unless adequate protection is provided.

34.21 After each length of tube is cut and made ready it shall be cleaned before installing in the system.

34.22 Piping and other components which have been prepared and are not to be used immediately shall be capped and sealed. During installation no component or length of tubing shall be unblanked longer than necessary for installation.

Charging and Evacuating Connections

34.23 Connections shall be provided in the high and low pressure sides of each compressor to facilitate evacuating and charging.

34.24 A pressure test using dry nitrogen or refrigerant shall be applied to each system after all pipework has been fitted.

34.25 A system shall be evacuated to a pressure of 10m bar or less which shall be maintained before breaking the vacuum with refrigerant, shall be added to raise the system pressure to 50psig suitable measures shall be taken to ensure the plant cannot run with this pressure prior to the attendance of refrigeration commissioning engineer.

Refrigerant

34.26 The refrigerant shall be properly chosen as not to act or react with any other material in the construction of the system. The whole system shall be cleaned and removed of water. There shall be no oxidation on the inside of the pipes where joints have been made. Refrigerant shall be in accordance with BS 4580.

Traps

34.27 Traps shall be provided on the suction pipe after the line leaves the compressor and after the line leaves the evaporator.

Sight Glass

34.28 A sight glass shall be installed on the condenser unit indicating refrigerant flow and moisture contact.

35.0 Soil and Waste

General Solvent Welded System

35.1 All soil pipes and fittings to be PVC-U, 1 system with solvent welded joints except where seal ring joints are required for thermal movement. All pipes and fittings to comply in all respects with British Standard 4514 and shall, where appropriate, bear the BSI kite mark.

General Pushfit System

35.2 All soil pipes and fittings to be PVC-U, with seal ring joints and solvent welded joints as required for certain fittings. All pipework to be correctly bracketed to control thermal movement. All pipes and fittings to comply in all respects with British Standard 4514 and shall, where appropriate, bear the BSI kite mark.

Fixing

35.3 All internal pipework to be supported using holderbats made of mild steel protected from corrosion by galvanising or plastic coating. The holderbats shall either locate around fitting sockets, to provide both anchor points, for support and as a fixed point to control thermal movement, or locate around pipe to act as a pipe steady permitting free longitudinal thermal movement of the pipework. Holderbats made of PVC-U may be used to support externally pipework.

Access

35.4 Access shall be provided where necessary either by means of an integrally moulded door on access branch type, access bend type, access pipes type, or alternatively by a two piece door, with integral clamp type, fitted directly into the pipe.

Jointing Details

35.5 The method of jointing to be employed shall be that of solvent welding using Liquid Weld cement manufactured to BS 6902. Pre-assembled seal ring joints shall be used where necessary to accommodate thermal movement or the upstream sockets of solvent type fittings may be converted to seal ring joints by the additional of a seal ring adaptor.

Automatic Air Admittance Valves

35.6 All A.A.V's from 32mm to 110mm in size to be approved by the British Board of Agreement and covered by Certificate No. 92/2811. Installation of al valves to comply with the guide lines set out in the above mentioned document.

Material Colour

35.7 The pipe and fittings shall be colour grey, to British Standard 5252:10.A.07, or black, white or rustic brown.

Waster Pipes General

35.8 All pipes and fittings to be MuPVC, with solvent welded joints except where seal ring joints are required for thermal movement.

35.9 All pipes and fittings to comply in all respects with the requirements of British Standard 5255 and shall, where appropriate, bear the BSI kite mark.

Or

35.10 All waste pipes and fittings to be polypropylene with seal joints. All pipes and fittings to comply in all respects with the requirements of British Standard 5254 and shall where appropriate, bear the BSI kite mark.

Or

35.11 All waste pipes and fittings to be with solvent welded joints except where seal ring joints are required for thermal movement.

35.12 All pipes and fittings to comply in all respects with the requirements of British Standard 5255 and shall, where appropriate, bear the BSI kite mark.

Connection of Waste Pipes to Soil Stack

35.13 Shall be either:

Type A

Bosses built in to the pipe run of one piece with in built gradients for the waste pipes of 1 ¼ degrees.

Or

Type B

Boss adaptors type fitted directly to bosses integral to soil branches etc.

Or

Type C

35.14 Bossed fitted directly to soil pipe consisting either of two parts with inner and outer flanges type within built gradients for the waste pipes of 1 ¼ degrees.

35.15 Where it is not possible to gain access to the bore of the soil pipe, self locking bosses with integral clamping action strap on basses saddle adaptor plus boss adaptor, that may be solvent welded directly onto the soil pipe using the appropriate size circular hole saw to cut the correct hole size.

Installation Requirements – General

35.16 The installation method of jointing and fixing shall comply in all respect with Geberit Terrain installation guide.

Pipe Support Requirements

35.17 The maximum intervals between pipe supports shall be:-

Nominal Size	Horizontal	Vertical
mm	m	m
32	0.5	1.2
38	0.5	1.2
50	0.9	1.2
82	1.0	2.0
110	1.0	2.0
160	1.0	2.0

Pipes shall be fixed in straight runs and all horizontal runs shall be laid to gradients in accordance with British Standard 5572 Code of Practice for Sanitary Pipework, and in any event not less than 18mm/m unless otherwise instructed.

Allowance for Thermal Movement

35.18 Expansion joints shall be provided at a maximum of 4 metre centres for soil, 2 metre centres for waste and between fixed points over 1 metre centres.

Inspection and Testing

35.19 The work shall be inspected and tested during installation at agreed stages. All work which will be concealed shall be tested before it is finally enclosed.

35.20 A final test shall be made upon completion for soundness and performance in accordance with British Standard 5572:1994 Code of Practice for Sanitary Pipework.