NORTHWICK PARK HOSPITAL

Design, Supply, Delivery, Installation and Commissioning of E,F&G Block LV Reconfiguration Works

Workmanship Specification

22/09/2022

Northwick Park Hospital

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WORKMANSHIP SPECIFICATION

Project Name:
Design, Supply, Delivery, Installation and Commissioning of E,F&G Block LV Reconfiguration Works

at
Northwick Park Hospital
London

Northwick Park Hospital

Watford Road

Harrow

London

HA1 3UJ

Project Number: (*insert)

Master Index

1006000	**Particular conditions**
1006001	Information provided by others
1006002	Provide everything necessary
1006003	Supply of information
1006004	Alternative manufacturer's equipment
1006005	Selection of manufacturers/suppliers
1006006	Coordination
1006007	Site dimensions and levels
1006008	Setting out
1006009	Site modifications
1006010	Dimensions
1006011	Terminal locations
1006012	Maintainability
1006013	Access for maintenance and operation
1006014	Notice of operations
1006015	Noise and nuisance
1006016	Suppressors
1006017	Working hours
1006018	Disposal of waste and materials
1006019	Storage
1006020	Protection and packaging
1006021	Confidentiality
1006022	Photographs
1006023	Materials used
1006024	Advertising
1006025	Patent rights
1006026	Beneficial use of installations
1006027	Interference with traffic
1006028	Defects liability
1006029	Right of access during defects liability period
1006030	Rationalisation of components
1006031	Software
1006032	Software time function
1006033	Fire precautions
1006034	Fuel for testing
1007000	**Pricing and costs**
1007001	Basis of contract
1007002	Prime cost sums
1007003	Provisional sums
1007004	Design costs
1007005	Overtime and allowances
1007006	Schedule of rates
1007007	Dayworks
1007008	Instructions and variations
1007009	Submission of final account
1008000	**Quality**
1008001	Quality control

1008002	Defects
1008003	Inspection before concealment
1008004	Workmanship and materials
1009000	**Management of the works**
1009001	Site staff
1009002	Design management
1009003	Programme
1009004	Progress
1009005	Ordering
1009006	Continuity of the works
1010000	**Submittals and approvals**
1010001	Submittals
1010002	Review of submittals
1010003	Mistakes in submittals
1010004	Schedule of drawings and submittals
1010005	Calculations
1010006	Equipment performance details
1010007	Manufacturers technical data
1010008	Equipment and plant performance guarantees
1010009	Technical information and queries
1010010	Preparation of drawings
1010011	Revisions of drawings
1010012	Method statements
1010013	Samples
1010014	Form and number of submittals to be provided
1011000	**Obligations and responsibilities**
1011001	General
1011002	General requirements
1011003	Building Regulations Part L
1011004	Builders work
1011005	Mechanical services
1011006	Automatic controls/BMS
1011007	Electrical services
1011008	Commissioning
1011009	Handover
1011010	During the 12 months after practical completion
1011011	Existing services
1012000	**Local Authority and building regulations**
1012001	Statutory authority approvals
1012002	Authority notices
1012003	Bye-laws, notices
1013000	**Health and Safety**
1013001	General requirements
1013002	Pre-construction information and construction phase plan
1013003	COSHH regulations
1013004	Asbestos
1013005	Risks to health and safety
1014000	**Builders work**
1014001	Builders work provided
1014002	Builder's work responsibilities
1014003	Marking out of builder's work holes on site
1014004	Structural steelwork

1014005	Pre-cast concrete
1014006	Builders work drawings
1014007	Scope of builders work
1015000	**Drawing definitions**
1015001	General
1015002	Tender drawings
1015003	Sketch drawings
1015004	Concept schematic drawings
1015005	Detailed schematic drawing
1015006	Technical design drawing
1015007	Detailed design drawing
1015008	Co-ordinated working drawing
1015009	Installation drawing
1015010	Installation wiring diagram
1015011	Manufacturer's drawing
1015012	Manufacturer's certified drawing
1015013	Record drawing
1015014	Builders work drawing and information
1015015	Controls logic diagrams
1016000	**Record documentation**
1016001	General
1016002	Record documents
1016003	Plant room and switch room drawings, schedules and schematics
1016004	Operating and maintenance manual specialist
1016005	Operating and maintenance manual requirements
1016006	Operating and maintenance manual layout
1016007	Operating and maintenance manual content
1016008	Building log book
1017000	**Commissioning and testing**
1017001	Definitions
1017002	General requirements
1017003	Testing and commissioning activities
1017004	Commissioning progress reports
1017005	Regulations and standards
1017006	Commissioning specialist
1017007	Personnel
1017008	Commissioning and testing programme
1017009	Instruments for testing and commissioning
1017010	Testing and commissioning record sheets
1017011	Static testing
1017012	Pre-commissioning checks
1017013	Load and performance simulation tests
1017014	Inspection by Employer's insurance company
1017015	System demonstration
1017016	Off-site testing
1017017	Pre-commissioning checks
1017018	Test certificates
1017019	Reports
1017020	Environmental testing
1017021	Performance testing
1017022	Authority witnessing and testing
1017023	Fine tuning

1017024	General requirements for mechanical services
1017025	Air distribution systems
1017026	Variable air volume systems
1017027	Natural gas installations
1017028	Medical gases
1017029	Refrigeration systems
1017030	Ductwork air leakage testing
1017031	Pipework pressure testing
1017032	Gravity drainage systems inside buildings
1017033	Underground drainage
1017034	Fire fighting systems
1017035	Automatic controls
1017036	BMS witnessing
1017037	BMS post-handover checks
1017038	General requirements for electrical services
1017039	Electrical services periodic inspection and testing
1018000	**Completion and handover**
1018001	Handover requirements
1018002	Reading of meters
1018003	Recommended spares
1018004	Supply of spare parts
1018005	Recommended tools
1018006	Supply of tools
1018007	Inspection by employer's insurers
1018008	Instruction of employer's staff
1018009	Operation of systems prior production of record documentation
1018010	System demonstration
1019000	**Maintenance**
1019001	Provision for 12 months maintenance
1019002	Proposal for annual maintenance contract
1019003	Maintenance of existing services
1020000	**Existing services**
1020001	General
1020002	Scope of existing services
1020004	Risks to health and safety
1020005	Making safe of existing services
1020006	Investigations and surveys
1020007	Maintenance of existing services
1020008	Connections to existing services
1020009	Decommissioning activities
1020010	Removal of existing services
2000000	**General information, standards and design criteria**
2001000	**General information**
2001001	Metric and imperial conversions
2001002	Units of measurement
2002000	**Standards and regulations**
2002001	General requirements
2002002	Standards and regulations
2002003	Copies of standards
2002004	Pressure directive
2002005	ATEX directive
2002006	EU declaration of conformity

2002007	Electromagnetic compatibility
2004000	**Design criteria**
2004001	General requirements
2004025	Internal lighting
2004026	External lighting
2004027	Emergency lighting
2004030	Lightning protection
2004031	Fire alarm systems
2004043	Spare capacities
2006000	**General workmanship and standards**
2006001	Working temperatures, operating and test pressures of services
2006002	Consistent material supplies, quality and finish
2006003	Materials and equipment
2006004	Access facilities
2006005	Services installed in ducts, trenches, subways etc
2006006	Facilities for the removal of equipment
2006007	Removal of pipework
2006008	Prevention of electrolytic action
2006009	Prevention of dezincification
2006010	Services crossing building expansion joints
2006011	Frost protection of pipework and services
2006012	Protection of buried services
2006013	Site personnel records of works and identification of work
2006014	Rubber matting
2006015	Welding
2006016	Brazing and bronze welding
3201000	**Pipework and fittings**
3201001	General requirements
3201002	Protection during construction
3201003	Pipework spacing
3201004	Steel pipework
3201005	Copper pipework (above ground)
3201006	Copper pipework (laid in ground)
3201007	Copper pipework (installed within screed)
3201008	Stainless steel pipework
3201009	Polyethylene pipe (laid in ground)
3201010	Galvanised mild steel pipework
3201011	Cast iron pipework
3201012	Cast iron water main
3201013	Plastic soil and waste pipework
3201014	Refrigerant pipework
3201015	Copper capillary fittings
3201016	Expansion of pipework
3201017	Expansion loops
3201018	Anchors and guides
3201019	Sets and pulled bends
3201020	Pipe sleeves and plates
3201021	Pipe sleeves through fire barriers
3201022	Pipe sleeves through acoustic barriers, enclosures and plantrooms
3201023	Pipe supports
3201024	Pipework brackets
3201025	Venting and draining

3201026	Air bottles
3201027	Automatic air vents
3201028	Dirt pockets
3201029	Overflows and condensate drains
3201030	Fan coil connections
3201031	Flushing bypasses
3201032	Positioning of control components
3201033	Press-fit pipework systems
3201034	Victaulic standard grooved piping system (carbon steel up to 300mmdiameter)
3202000	**Vales and pipework ancillaries**
3202001	General requirements
3202002	Provision of lockshields on valves
3202003	Pipeline strainers
3202004	Radiator Valves
3202005	Thermostatic Radiator valves
3202006	Safety and relief valves
3202007	Isolating valves (LTHW, CHW, Condenser water)
3202008	Valves for flow regulation
3202009	Check valves
3202010	Commissioning sets
3202011	Automatic balancing valves
3202012	Isolating valves (portable water, hot and cold water services)
3202013	Check valves (portable water, hot and cold water services)
3202014	Double check valves (hot and cold water services)
3202015	Butterfly valves
3202016	Float operated valves
3202017	Stop valves 15mm – 50mm
3202018	Tundishes
3202019	Draw-off cocks
3202020	Natural gas service isolation valves
3202021	Gas shut-off valves
3202022	Flexible pipe connections (up to 10 bar and 100°C)
3202023	De-aerators and dirt separators (LTHW, CHW)
3205000	**Thermal insulation**
3205001	General requirements
3205002	Definitions
3205003	Workmanship
3205004	Fire performance
3205005	Vapour barrier
3205006	Materials
3205007	Insulation thickness
3205008	Application
3206000	**Identification of services**
3206001	General requirements
3206002	Valve labels and charts
3206003	Identification of services
3206004	Pipework services
3206005	Ductwork services
3206006	Identification of plant
3207000	**Noise and vibration**
3207001	General requirements
3207002	Attenuators

3207003	Air transfer/cross talk attenuators
3207004	Acoustic duct linings
3207005	Acoustic enclosures
3207006	Acoustic louvres
3207007	External acoustic duct lagging
3207008	Vibration isolation
3207009	Plant bases
3207010	Pipework flexible connections
3207011	Ductwork flexible connections
3207012	Acoustic testing
3208000	**Instrumentation and metering**
3208001	Water temperature gauges/thermometers
3208002	Pressure/altitude gauges
3208003	Temperature and pressure test points
3208004	Digital Temperature Meter
3303000	**Pumps and pressurisation**
3303001	General requirements
3303002	Gauges
3303003	Guards
3303004	Belt drives
3303005	Centrifugal pumps
3303006	Twin pump sets
3303007	Glandless pumps
3303008	Sump pumps
3303009	Semi rotary hand pumps
3303010	Oil circulating and oil transfer pumps
3303011	Closed system pressurisation units
3303012	Cold water booster set
5000000	**BUILDING MANAGEMENT SYSTEM AND AUTOMATIC CONTROLS**
5201000	**BMS/control systems – workmanship & materials**
5201001	Standards
5201002	Control panels
5201003	Field Devices
5201004	Field controllers
5201005	Actuators
5201006	Valves
5201007	Dampers
5201008	Variable speed inverter drives
5201009	Control functions and routines
5201010	BMS configuration
5201011	System communications
5201012	Integration with fire detection systems
5201013	Operator workstation
5201014	Energy metering
5201015	Connection to plant and control equipment
5201016	Cabling
5201017	Commissioning and testing
5201018	Training
5201019	Post – Handover Checks
5201020	Documentation
5201021	Software
5202000	**BMS/Automatic controls – particular requirements**

5202001	General requirements
5202002	Performance objectives
5202003	Plant operating criteria
5202004	Description of works
5202005	Exclusions
5202006	Free issue equipment
5202007	Interfacing requirements
5202008	Network architecture
5202009	General control philosophy
5202010	System requirements
5202011	Controls functions
6201000	**Containment systems**
6201001	General requirements
6201002	Cable ladder rack
6201003	Perforated cable tray
6201004	Cable basket
6201005	Steel trunking
6201006	PVC and uPVC Trunking
6201007	Steel conduit
6201008	Steel Adaptable Boxes
6201009	Condensation management in steel conduit installations
6201010	PVC Conduits and Accessories
6201011	PVC Conduit Boxes
6201012	Protective conductors in PVC trunking and conduit
6201013	Excavation and laying of cables, external
6201014	Cable warning covers
6201015	Cable ducts and draw pits
6201016	Sealing of duct entries to buildings (including service pipes)
6202000	**Cabling systems**
6202001	General requirements
6202002	Unarmoured cables
6202003	Armoured cables
6202004	Flexible cables and cords
6202005	Mineral insulated cables (MICS)
6202006	Soft skin fire performance cables
6202007	ELV cables for data and communication use
6202008	Cable installation & support
6202009	Cable glands
6202010	Cable jointing and terminations
6202011	Cable installation
6202012	Inspection and testing
6202013	Identification of cables
6203000	**Low voltage modular wiring systems**
6204000	**Testing and certification - General**
6204001	General requirements
6204002	Approval and acceptance
6204003	Protective device certification
6204004	Personnel
6204005	Inspection, test and electrical installation certificates
6204006	Works tests
6204007	Site tests
6204008	Commissioning

6204009	Periodic inspection and testing
6302000	**HV Cables**
6302001	General
6310000	**Generators**
6310001	General
6310002	Engine Type
6310003	Local Acceptance
6310004	Cooling
6310005	Governor
6310006	Starting
6310007	Battery Charging
6310008	Lubrication
6310009	Filters
6310010	Alternator
6310011	Voltage Regulation
6310012	Insulation
6310013	Coupling
6310014	Base-frame
6310015	Safety Guards
6310016	Acoustic Enclosure
6310017	Fuel Oil
6310018	Generator Protection
6310019	Synchroniser and Control Panel
6310020	Manual Control
6310021	Output Breakers
6310022	Enclosure
6310023	Material and Finish
6310024	Bus Bars
6310025	Earthing Connections
6310026	Internal Wiring and Terminations
6310027	Cable Glands and Terminations
6310028	Labels
6310029	Instruments
6310030	Current Transformers
6310031	Locking Facilities
6310032	Interlocking
6310033	Circuit Breakers
6310034	Control/Monitoring
6310035	Load Bank Connection
6310036	Panel Location/Mounting
6310037	Remote Monitoring
6310038	Load Sharing
6310039	Restoration of Mains Supply
6310040	Overcurrent and Short Circuit Fault Protection
6310041	Testing And Commissioning
6321000	**Switchboards**
6321001	General
6321002	Rated voltage
6321003	Switch board assembly
6321004	Busbars
6321005	Earthing
6321006	Identification of switch boards

6321007	Labels and diagrams
6322000	**Panel boards**
6322001	General
6322002	Rated voltage
6322003	Panel board assembly
6322004	Busbars
6322005	Earthing
6322006	Identification of switch panels
6322007	Labels and diagrams
6323000	**Distribution boards**
6323001	General
6323002	Identification of distribution boards
6324000	**Consumer units**
6324001	General
6325000	**Enclosures**
6325001	General
6326000	**Switch fuses and fused switches**
6326001	General
6326002	Ironwork for switch frames
6326003	Identification of switched fuses and fused switches
6327000	**Circuit breakers and RCD's**
6327001	General
6327002	Air circuit breakers (ACB)
6327003	Moulded case circuit-breakers (MCCB)
6327004	Miniature circuit breakers (MCB)
6327005	Residual current devices and residual current breakers with overload protection
6328000	**Fuses**
6328001	General
6329000	**Contactors**
6329001	General
6330000	**Protection against voltage disturbances**
6330001	General
6330002	Voltage disturbances from an external source
6330003	Voltage disturbances from an internal source
6331000	**Metering**
6331001	General
6331002	Utility meters
6331003	Meter tails
6331004	Main switch board or panel board
6331005	Energy metering strategy
6332000	**Power factor correction**
6332001	General requirements
6341000	**Light switches**
6341001	General requirements
6342000	**Industrial socket outlets**
6342001	General requirements
6343000	**Fused connection units**
6343001	General requirements
6344000	**Double pole switches and isolators**
6344001	General requirements
6347000	**13A Socket outlets**
6347001	General requirements

6351000	**Lighting general requirements**
6351001	General
6351002	Construction
6351003	Control gear and wiring
6351004	Internal wiring
6351005	Luminaire selection and design
6351006	Luminaire noise
6351007	Lamp holders
6351008	Lamps
6351009	Luminaire Efficacy
6351010	Plug-in ceiling roses (PCR)
6351011	Flexible cables and cords
6351012	Lighting installation 6351013 Maintenance Factor
6352000	**Floodlighting**
6352001	General
6352002	Floodlights with symmetric distribution
6352003	Floodlights with asymmetric distribution
6357000	**Linear fluorescent luminaires**
6357001	General
6357002	Batten luminaires
6357003	Surface modular luminaires
6357004	Recessed modular luminaires
6358000	**Self-contained emergency lighting**
6358001	General
6358002	Self-contained emergency luminaires
6358003	Self-contained “self-test” emergency lighting
6358004	Centralised and remote monitoring of emergency lighting 6358005 commissioning
6360000	**Internal LED lighting**
636001	General
6361000	**External LED Lighting**
6361001	General
6370000	**Earthing**
6370001	General requirements
6371000	**Main earth terminals**
6371001	General
6372000	**Dedicated earths**
6372001	General
6373000	**Earth electrodes and pits**
6373001	General
6374000	**Earthing for HV/LV transformers**
6374001	General
6375000	**Equipotential and supplementary bonding**
6375001	General
6377000	**Protective multiple earthing (PME)**
6477001	General
6378000	**Lightning protection**
6378001	General
7301000	**Fire alarm systems**
7301001	General
7301002	System types
7301003	Manual call points

7301004	Heat detectors
7301005	Point type smoke detectors
7301006	Beam type smoke detectors
7301007	Multi sensor detectors
7301008	Flame detectors
7301009	Aspirating systems
7301010	Video smoke detection
7301011	Sounders
7301012	Visual alarms
7301013	Portable alarms
7301014	Control and indicating equipment
7301015	Power Supplies
7301016	Remote Signalling
7301017	Fire alarm interfaces
7301018	Wiring
7301019	Installation and test
7301020	Commissioning and handover
7301021	Documentation
7301022	Logbook
7310000	**Data and voice systems – hard wired**
7310001	General requirements
7310002	Design and installation standards
7310003	Cat 5e copper cable
7310004	Cat 6 copper cable
7310005	Cat 6a copper cable
7310006	Accessories
7310007	Patch cords
7310008	Cabled fibre optics
7310009	Multimode fibre
7310010	Single mode fibre
7310011	Wireless data network (WiFi)
7310012	Testing
7310013	Manufacturer’s warranty
7312000	**Power over Ethernet (PoE)**
7312001	General
7312002	Cabling design and installation standards
7312003	PoE Standards and Regulation
7312004	Powered devices (PD)
7312005	Power sourcing equipment (PSE)
7312006	Mid spans
7312007	Circuit design capacity
7312008	Cable type
7312009	Maximum cable length
7312010	Temperature rise in bunched cables
7312011	PoE Types and classification

Section 1000000 – General conditions

1006000 PARTICULAR CONDITIONS

1006001 Information provided by others

Instructions, drawings, or other information required to be provided by the CA will be provided in due time upon written request provided that such information is not requested unreasonably distant from nor unreasonably close to the date upon which it is necessary.

Provide written requests to the CA in good time for any information required.

1006002 Provide everything necessary

Provide everything necessary for the proper execution and completion of the Works in accordance with the intent and meaning of the contract documents.

Details of construction or materials that have not been referred to in the specification or drawings but the necessity for which may reasonably be implied or inferred from the said specification or drawings or which are usually or essential to the completion of all works in all trades, shall be provided and installed with no additional costs.

1006003 Supply of information

The CA shall provide supplementary information from time to time as may be necessary to enable the completion of the Works in accordance with the contract conditions. Allow for such progressive release of further information by the CA during the course of executing the Works.

In order to facilitate the orderly and timely production of all further information that shall be considered necessary, submit to the CA for approval a programme indicating the progressive release of such information to enable the completion of the Works in accordance with the contract conditions.

The CA shall issue all the drawings that are considered necessary to enable the preparation of co-ordinated installation and shop drawings.

1006004 Alternative manufacturer's equipment

Alternative manufacturers' equipment and materials shall be equivalent in every respect to that specified.

Submit to the CA a separate compliance statement for each such alternative to demonstrate the proposed alternative is fully equivalent to the specified item. The statement shall include:

1. Company details
2. Full technical data and performance characteristics
3. Certification attained
4. Details of any implications or consequential amendments to the design and/or construction / installation of other parts of the Works
5. A complete and precise statement of the effects on cost. Relevant cost savings will be deemed to have allowed for all consequential costs associated with amendments of other parts of the Works. Identify additional costs arising from necessary changes to the details of the installation, including changes to the design and drawings, as well as any associated ancillary equipment
6. Effects on construction, programme, maintenance, cost in use or other differences
7. Confirm equivalence in quality, operation and space requirements to those items which have been specified by name.
8. The impact on Part L compliance including the CO_2 Target Emissions Rate and the final 'as constructed' CO_2 Buildings Emissions Rate.

Include for all necessary measures to ensure alternative manufacturer's equipment and the total installation is equivalent to that specified.

Where alternative equipment or materials offered have been accepted by the CA, either prior or post to the award of the contract, undertake and be responsible for the redesign of all services and builder's work affected by these equipment changes. No additional costs or extension or delay to the programme will be allowed.

The acceptance of any alternatives shall be at the discretion of the CA, who is not bound to accept any alternatives. Alternatives that would involve significant changes to other work will not be considered.

Alternative offers will only be considered if accompanied by a compliant tender.

1006005 Selection of manufacturers/suppliers

Where manufacturers, suppliers or installers of products are not identified by name select products that comply in all respects with the specification and demonstrate such compliance.

Where manufacturers, suppliers or installers of products are identified by name, or names, but no reference is made to "or approved" equivalent use these exclusively.

Where manufacturers, suppliers or installers of products are identified by name, or names, but reference is made to "or approved" equivalent alternatives may be selected and shall be submitted to the CA for approval.

Where manufacturers, suppliers or installers of products are identified by name, or names, but reference is made to "or approved" equivalent the submitted tender must include the named or one of the named suppliers. Alternatives may be selected and shall be submitted to the CA for approval, separately.

1006006 Coordination

All aspects of the Works require detailed co-ordination to avoid any possible clash or conflict with other trades and disciplines.

Undertake such co-ordination in relation to the Works.

No extra cost or claim will be allowed due to conflict of works or installations, where full liaison with other trades and disciplines would have prevented such an occurrence.

Initiate co-ordination meetings with all other trades and disciplines and undertake all surveys that are necessary. Minute these meetings and submit to the CA no longer than one week after the date of the meeting. The minutes shall be suitably detailed to cover all matters raised and indicate which party requires to action matters.

Identify at an early stage and report prior to commencement of the works, any conflict in the positioning between engineering services, the structure or architectural elements. Ascertain if structural tolerances have been exceeded, and service voids reduced, and take site on-site dimensions. Advise the CA of any proposed corrective action to resolve any conflicts.

When any new, revised or updated architectural, structural or services information is issued by the CA under the authority of an Instruction, examine such information and if necessary modify the works accordingly to prevent any clashes or abortive work due to such instruction.

No extra cost or claim will be allowed to cover any clashes or abortive work that result from not requesting an explanation or seeking clarification in respect of any such revision. Any remedial works shall be carried out at no cost to the contract.

Be responsible for the co-ordination of the installation of services and take account of all other works and trades either during or prior to their incorporation into the works.

Where minor clashes of services occur on site that were not foreseeable at the design or co-ordination drawing stage then these clashes or minor co-ordination matters shall be resolved by discussion and agreement with other trades and disciplines. The CA shall be informed of the action to be taken by an approved means.

No instructions will be issued to cover such minor clashes.

1006007 Site dimensions and levels

Use a laser leveling system to install all building services installations wherever possible and co-ordinate the measurements with all other trades and disciplines to prevent any clashes.

Obtain all dimensions and levels on site for the actual setting out of the works. Ensure these dimensions are available before proceeding with the Works.

Do not take dimensions from drawings by scaling. Where dimensions are indicated on the drawings check these on site, as appropriate, to ensure construction and manufacturing tolerances can be accommodated.

As the development advances measure on site all works by others that may foreseeable affect the Works. These dimensions shall be incorporated into the drawings or marked up on revised drawings if already issued.

No extra cost or claim will be allowed for any errors arising from inaccurate setting out or failure to check actual site dimensions. Reimbursement will be sought for any abortive expenditure.

Any comments, discrepancies or divergences that will / may affect the Works shall be brought to the attention of the CA in adequate time to avoid delay or abortive expenditure.

1006008 Setting out

Ensure all items of plant and equipment can be installed in the available space and that there is adequate access to install plant to its final position in a safe manner.

Install the Works so as to be accessible for safe operation, maintenance, repair and future replacement. Deviations from the drawings to achieve this shall be agreed with the CA and written approval obtained before installation work commences. Final position and size of access doors shall be agreed with the CA.

Ensure uniform, neat and symmetrical arrangements of wall, floor and ceiling mounted equipment. Agree with the CA all necessary horizontal and vertical alignment before installation work commences.

Amend any errors arising from inaccurate setting out or lack of site co-ordination at no additional expense to the contract.

1006009 Site modifications

Site modifications to plant, equipment or assemblies shall not be undertaken without approval from the CA.

Authorised site modifications shall be in accordance with manufactures' recommendations and instructions.

Ensure that all modifications undertaken comply with the relevant standards and all test certification obtained.

1006010 Dimensions

Where installations are dependent upon site dimensions ensure that these are available before proceeding with the Works.

Dimensions should not be scaled from drawings.

Where dimensions are indicated on drawings check these on site, as appropriate, to ensure building construction tolerances and manufacturing tolerances can be accommodated.

Equipment should not be ordered or manufactured using dimensions indicated on the Tender drawings.

1006011 Terminal locations

The positions of all connection points, accessories, equipment and other room terminals as shown on the tender drawings are approximate and for guidance in the preparation of the tender.

Agree with the CA the room terminals that are subject to final positioning on site.

Allow for the movement of all such terminals up to a radius of 2.0 m from the positions shown on the drawings.

Confirm with the CA the mounting heights before commencing work on site.

1006012 Maintainability

Demonstrate that all plant and equipment incorporated into the Works can be safely and easily maintained in full compliance with Health and Safety legislation, CDM requirements, British Standards and (where applicable) Health Technical Memoranda.

Ensure that all access panels/doors are unobstructed and that adequate space is provided for future replacement of plant or parts.

1006013 Access for maintenance and operation

Design, co-ordinate, supply and install all access platforms, access covers, gratings, ladders, stairs, rails and protecting elements required for future maintenance and operation of the Works.

The installations shall be structurally stable and safe in use. Detail design drawings shall be provided together with builders work information and submitted for review prior to fabrication and installation. Drawings and calculations shall also be submitted to the structural engineer for comment.

Walkways and stairways shall be in accordance with BS 5395 Parts 1 and 3 (Stairs, ladders and walkways) and BS EN ISO 14122 (Safety of machinery – Permanent means of access to machinery). Include all toe plates, railings, guards and infills necessary to ensure a safe installation.

Flights of stairs shall not exceed 16 risers. Longer stairways shall be provided as equal flights separated by landings.

Handrails, platforms and walkways shall be designed for heavy duty. External and plant room installations shall be of the open mesh type fabricated from mild steel sections hot dip galvanised after manufacture in accordance with BS EN ISO 1461. Bolts, nuts washers and other fastenings shall be hot dip galvanised or zinc plated.

External installations shall be finished with a polyester powder coating in a BS or RAL colour advised by the CA.

1006014 Notice of operations

Work that requires interruption or interference with the operation of any existing services or buildings shall not be commenced without prior written permission of the CA.

1006015 Noise and nuisance

Ensure that the Works are undertaken with as little noise as possible.

Ensure no nuisance by noisy working is caused to the Employer or occupants of premises next to the site boundary

Take all necessary precautions to prevent nuisance from smoke, rubbish and other causes.

Fit all compressors, percussion tools and vehicles with effective silencers of a type recommended by the manufacturer of the equipment.

1006016 Suppressors

Ensure all internal combustion engines used in the execution of the Works are fitted with efficient suppressors in the ignition system in accordance with the recommendations of British Standards so as to prevent electrical interference to radio or television receiving equipment in the vicinity.

All temporary electrical installations, such as motors or the like, shall be prevented from creating such interference and shall be fitted with suppressor equipment in accordance with British Standards and to the satisfaction of the CA.

1006017 Working hours

Working hours shall be as defined in the Trust working standards

1006018 Disposal of waste and materials

Disposal of waste and materials shall be accordance with the Site Waste Management Plans Regulations.

Remove from the site any rubbish and debris arising out of the execution of the Works on a daily basis.

Do not discharge any oil, noxious liquids or gases.

All water discharged shall be reasonably free from impurities.

Ensure all debris, dirt and redundant items created by the Works are removed from the site.

Ensure adequate waste facilities are provided to ensure all waste is sorted out on site appropriately, segregated and disposed of for recycling / reclamation where possible.

Ensure that chemicals, solvents and other liquids are disposed of safely and are only discharged to drain in compliance with Environment Agency, local statutory and local authority requirements.

Ensure all onsite materials and activities are carried out to avoid any damage to local wildlife, plant life and/or habitats.

The Works shall be thoroughly cleaned, all splashes, deposits, temporary markings, coverings and rubbish shall be removed leaving the site and Works in a fit condition for occupation / use and to the satisfaction of the CA.

1006019 Storage

Provide sufficient weatherproof, safe and secure storage for all materials and equipment.

Equipment and materials shall be offloaded, stored and transported about the Works in accordance with manufacturer's recommendations.

Open ends on all ductwork, tubes, conduit, trunking and associated equipment shall effectively be plugged, capped or sealed whilst in storage and during transportation to site. Provide racks to prevent distortion of pipes, conduit and similar materials.

1006020 Protection and packaging

Ensure that all plant, equipment and materials and particularly prefabricated portions of the Works are properly packaged and protected against damage during delivery, storage and until fully, finally and properly incorporated into the Works and set to work.

Submit to the CA a method statement in regard to the protection proposals for both stored and installed plant, equipment and materials prior to commencement of the works on site.

All materials and equipment and materials shall be offloaded, stored and transported in accordance with manufacturer's recommendations.

All plant, equipment and materials shall be protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others.

Provide racks to prevent distortion of pipes, conduit and similar materials.

All electrical equipment and components shall be kept dry and free from dust.

Cover all items with polythene sheeting except when being worked upon.

Cap all open ends of pipes, ducts, conduit, and trunking etc except when being worked upon

After removal of any temporary protection paint parts liable to corrosion.

Filter media shall only be installed when the plant items concerned are commissioned and tested.

Protect all finished items from damage. Install items such as grilles, diffusers, light fittings, and switch accessories etc. as near to completion as practicable.

Any plant or equipment subject to incorrect storage or inadequate protection will be deemed unacceptable for incorporation into the works and new plant or equipment will be required as a replacement. Plant, equipment and materials suffering deterioration or damage shall be replaced prior to handover at no additional cost to the contract.

1006021 Confidentiality

No information related to the contract works shall be given to the press or other media without the written permission of the CA or Employer.

1006022 Photographs

Provide progress colour photographs in digital format of the Works taken at intervals to be agreed with the CA. Prior to the commencement of the Works agree with the CA the format of the photographs to be submitted to the CA.

Photographs shall not be published or otherwise circulated without the permission of the CA and no unauthorised photographs of the site or the Works or any part thereof shall be taken except with the permission in writing of the CA

Photographs shall be taken at the following locations:
1. All plantrooms and electrical switchrooms

2. All services risers
3. Each floor as the 1st fix installation of the Works proceeds
4. Any other locations agreed with the CA prior to commencement of the Works.

Provide photographic details of all engineering services, which are concealed within the building before final concealment.

As instructed by the CA provide photographs of all areas in which the Works are to be installed prior to the commencement of the Works to record the condition of:
1. Existing services
2. Concrete Bases
3. Services Containment
4. Generators
5. Tree and Hedge removals
6. Fixed equipment

All photographs are to be numerically identified and cross- referenced to marked up plans showing the position, direction and field of view for the respective photograph.

Progress photographs shall be submitted to the CA within one week of being taken and shall have the date and time when taken digitally displayed on the photograph

1006023 Materials used

Deleterious materials shall not be utilised on any part of the Works.

Check with manufacturers and suppliers of products and materials that products do not contain any such deleterious materials. If any specified product contains such material notify the CA in writing and request an alternative specification of product, manufacturer or supplier.

Use the best information available to ensure deleterious materials are not incorporated into the Works either directly or within products, whether or not specifically specified.

All materials supplied shall be a type that will not support bacteria.

The following deleterious materials shall be excluded from the Works:
1. Materials in which chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC) or HFA's have been used as blowing agents.
2. Halon or any other substances causing ozone depletion.
3. Chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC) based refrigerants. (All refrigerants shall be zero ODP).
4. Asbestos or products containing asbestos.
5. Urea formaldehyde or materials which may release formaldehyde.
6. Materials comprised in whole or part of man-made and/or naturally occurring mineral fibres which have a diameter of 3 microns or less and a length of 200 microns or less or which contain fibres not sealed or otherwise not stabilised to ensure that fibre migration is prevented.
7. Lead where the metal or its corrosion products may be directly ingested, inhaled or absorbed.
8. Lead-based paints or primers
9. Polyurethane or polyisocynate foam
10. Polychlorinated biphenyls (PCBs) or similar compounds
11. Pentachorophenol, lindane or tributyltin (TBT) oxide
12. Extruded polystyrene other than low ozone depletion materials
13. Materials manufactured with any form of animal hair.
14. Materials that support bacteria.

Substances publicised by the Health and Safety Executive, Building Research Establishment, British Standards Institution or other authorities or professional bodies as being deleterious to Health and Safety shall not be incorporated into any part of the Works.

All jointing materials shall be of a type approved by the respective authority.

Warrant that deleterious materials are not incorporated in the Works and provide a written compliance statement to the CA prior to commencement of the Works.

Notify the CA, in writing, as soon as reasonably practicable of any material designated by the Building Research Establishment, British Standards or codes of practice as deleterious at any time during the contract

1006024 Advertising

No form of advertising will be allowed on any part of the site or the Works without written CA approval.

1006025 Patent rights

Indemnify against all claims, costs or expenses in connection with any patented, copy-righted or protected articles supplied and used on or in connection with the Works.

Any payments or royalties payable in one sum or by installments shall be included in the contract price and paid to whom so ever they may become due.

In the event of any claim being made in connection with such patented or protected articles, conduct any negotiations or litigation in connection with such claim at own expense.

1006026 Beneficial use of installations

Systems may not be used before practical completion without prior written approval of the CA.

Systems used before practical completion not for the benefit of the Employer must have all defective consumable elements (including lamps and tubes) replaced by new not more than seven days prior to practical completion.

Maintenance shall be carried out in accordance with manufacturers' recommendations. Final manufacturer guarantee periods shall not be affected and a written guarantee to this effect shall be obtained.

If required prior to practical completion and after the issue of a written instruction by the CA, operate the installations or any part of them, provided that such operation is practicable and does not prejudice the responsibilities and obligations under the contract. All labour and other direct operating charges arising from the use of such installations will be reimbursed at daywork rates or where no such rates are applicable at reasonable rates to be agreed with the CA beforehand.

1006027 Interference with traffic

Maximum facilities for access and transit shall be provided in all works that may interfere with the traffic on the roads, paths and footways. Should any part of the Works be executed in such a way as to cause unnecessary obstruction to traffic with neglect to remove or remedy the same forthwith when called upon to do so, then any obstruction shall be removed and the costs recovered.

1006028 Defects liability

Liability for making good defects in the installations shall be for a period of twelve months from the date of issue of the certificate of practical completion for the installations.

If as part of liability for defects, it is necessary to replace or renew any portion of the contract Works, the defects liability period in respect of that portion of the contract Works shall be deemed to commence from the date of such replacement or renewal.

If the replacements or renewals are of such a character as may affect the efficiency of the contract Works or any portions thereof, the CA may require that new tests be carried out to demonstrate that the plant is continuing to work satisfactorily.

Take all precautions in the remedying of defects in the contract Works to minimise the risk of damage to the buildings, the decorations, the fittings and the equipment. In the event of such damage occurring bear the cost of replacement or making good, subject to the proviso of being granted the benefit of any settlement in respect of such damage accepted by the insurers under the insurance policies taken out in accordance with the requirements of the contract.

Agree with the CA a programme for the carrying out and the completion of any work not finally finished at the time of the contract Works being offered for acceptance and which does not prejudice the issue of a practical completion certificate. This work may be requested to be executed out of normal hours and no additional costs will be accepted for this action.

Prepare and submit records of failures or malfunctions of any part of the Works during the defects liability period, together with remedial action taken, subsequent re-testing and the results.

Notify the CA of damage, failures or malfunctions to the Works caused by incorrect operation of the installations, vandalism or other actions by a third party.

Rectify all defects due to materials or workmanship or other faults that occur, including those notified by the Employer or CA, during the defects liability period with the minimum of delay and at no additional cost to the contract.

Produce prior to practical completion a written statement for the approval of the CA that sets out the how the defects which arise during the defects liability period will be rectified to ensure that disruption to the Employer's use of the building is kept to a practical minimum. This work may be required to be executed out of normal hours and no additional costs will be accepted for so doing.

Inform the CA in writing when all defects are finally rectified so that an inspection may be undertaken by the CA.

1006029 Right of access during defects liability period

Right of access will not be unreasonably withheld, at all reasonable working hours and at own risk and expense, to any part of the contract Works for the purpose of inspecting the working of the installations or to the records of the working and the performance thereof for the purpose of examining the same and taking notes from.

Subject to CA approval, that shall not be unreasonably withheld, undertake any tests considered necessary at own risk and expense.

Liaise closely with the Employer's staff during the defects liability period and all necessary remedial works and/or rectification of defective materials and equipment shall generally be carried out in such a manner as to avoid or minimise shut-down time and inconvenience to the Employer

1006030 Rationalisation of components

Similar items of apparatus and equipment shall be made and provided by the same manufacturer where practicable and corresponding parts of all apparatus and equipment shall be interchangeable to reduce the need for different attention and spares.

1006031 Software

Obtain on behalf of the end user all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating.

Application software shall be in compliance with BS 7649.

Provide back-up copies of any software and two back-up copies of all software items, as commissioned.

1006032 Software time function

Ensure all equipment utilizing a time and/or date function, supplied and used on the project, meets the following conformity requirements:

1. All time and date set functions in either software or firmware shall use a minimum 64 bit integer to determine the current time and date as well as any processes or events that rely on time and/or date settings
2. No value for date will cause any interruption or adverse effect in performance
3. Where existing equipment is re-used, the date and time based functionality and performance must be verified to ensure it utilises a minimum 32bit integer to determine the current time and date as well as any processes or events that rely on time and/or date settings. Correct time and date functionality shall be maintained for a minimum of 25 years after practical completion
4. Leap years must be recognised as a leap year

1006033 Fire precautions

Take all reasonable fire precautions in respect of stores, workshops and other installations. Where it is necessary to use any naked flame or welding equipment in executing the Works and where combustible materials are in use, adequate protection shall be given to other adjacent materials and personnel. Suitable fire extinguishers shall be readily available at the position where such work is proceeding.

1006034 Fuel for testing

Fuel for testing and operating the Works will be included within the contract price and due allowance made within the tender

1007000 PRICING AND COSTS

1007001 Basis of contract

The contract shall be
• on a lump sum based on the specifications and drawings and accordingly shall not be subject to re-measurement.

The contract price shall include everything necessary for all design, co-ordination, installation, supervision, services, operations, materials, consumables, labour and plant necessary for and incidental to the proper construction, completion, testing, commissioning and adjustment of the Works to the satisfaction of the CA and in accordance with the conditions of contract, the specifications and the drawings.

1007002 Prime cost sums

The term Prime Cost Sum shall mean the nett cost paid for an item or items of equipment or material or work executed.

Where prime cost sums are included these shall be at the disposal of the CA who shall give written instructions for their expenditure and the CA shall have the power to nominate persons or firms to execute work or supply goods against such sums.

All prime cost sums shall be adjusted by the CA in the final account, the work undertaken or goods supplied against such sums being charged on the basis of the net accounts of the installers or suppliers, plus the percentage addition stated in the tender to cover profit.

1007003 Provisional sums

Include in the contract price the provisional sums detailed in the forms of tender. Any part or the whole of these sums unexpended will be deducted from the final amount due.

1007004 Design costs

The costs for undertaking the design activities and production of information during the design stage shall be stated in the tender.

1007005 Overtime and allowances

Include for all necessary overtime in the contract price to complete the Works in compliance with the contract programme.

Payment will be made for the extra cost of overtime only if a prior written CA instruction to work such overtime has been issued together with agreement to accept the costs involved.

1007006 Schedule of rates

A quantified schedule of rates shall be prepared and submitted within 4 weeks of request

A quantified schedule of rates accepted by the CA shall only constitute part of the contract in the following respects:

1. The descriptions of the works and the rates and prices contained therein shall be used for the purpose of adjusting variations
2. The quantities contained therein shall be used to facilitate the preparation and the checking of interim applications for payment
3. The provisional and prime cost sums contained therein shall be subject to adjustment in accordance with the rules and procedures contained in the contract conditions.

Failure to provide sufficient information to satisfy the CA of the accuracy of the schedule of rates shall entitle the CA to impose a schedule of rates for the Works. All costs associated with the preparation and issue of this schedule of rates shall be at the installer's cost.

1007007 Dayworks

Where authority is given for work to be executed on a daywork basis, original vouchers giving the fullest particulars of hours worked, names of craftsmen and labourers, description of work executed and materials and plant used, must be forwarded to the CA through the contract procedures not later than the end of the week following that in which the work has been executed.

The daywork sheets shall be numbered in sequence, and all sheets are to be signed by the agent/foreman responsible and site representative of the CA. Such signatures are only to be taken as certifying that the time, materials and plant are correct, and shall not be held to justify a claim that the work shall be so charged or that it cannot be measured and priced according to the terms of the contract.

The value of work accepted by the CA to be paid on a daywork basis shall be calculated in the manner and in accordance with the rates quoted in the daywork Schedule.

1007008 Instructions and variations

Instructions will be issued in writing and confirmed in a similar manner. Oral instructions have no effect unless confirmed in writing.

Submit to the CA, within 10 working days of the receipt of written instructions, the cost of each variation showing the quantities and rates applicable for all materials, etc employed in accordance with the schedule of rates. No work will be certified for payment until this information is provided.

In order to avoid delays arising from the uncertainty or misinterpretation of instructions issued put in place procedures for dealing with instructions and in particular requesting for clarification where the instruction is not clearly understood.

1007009 Submission of final account

As a minimum requirement immediately after the practical completion of the contract Works, submit a draft final account in duplicate to the CA using the contract procedures for checking purposes together with all the necessary supporting documents.

During the course of the Works progressively submit valuation of variations, omissions and provisional work forming part of the Works and where appropriate in accordance with principles defined in this sub-clause,

The basis for the determination of such valuation shall be the Quantified Schedule of Rates prepared and submitted at the time of tender and accepted by the CA.

All valuations as aforesaid prepared shall be submitted using the contract procedures to the CA for approval.

1008000 QUALITY

1008001 Quality control

Prepare a method statement to indicate fully the quality control programme for the Works and indicate clearly the role of the CA in that programme.

The objective of the quality control programme shall be:

1. Full compliance with the ISO 9001 standards and procedures
2. Full compliance with the specification in regard to materials and workmanship
3. Establishment of standards that will be acceptable to the CA by means of a sample installations prior to full scale erection of all major elements and trades required
4. Submission to the CA for agreement of any samples of proposed manufacturer's items to be utilised in the Works prior to ordering
5. Establishment of method statements defining quality standards

The quality control system will be subject to audit at any time during the duration of the contract.

The CA shall issue a quality control instruction where the installation fails to meet the standard required in the specification.

Where the installation fails to meet the required standard submit written proposals for compliance.

The quality control system shall include a suitable methodology and recording procedure which shall enable the personnel responsible for any work to be identified.

1008002 Defects

Prepare a system of recording defects in order to assess and monitor. The defects register should record:

- Reference
- Description of the defect
- Remedial works proposed
- Agreement to remedial works proposed
- Confirmation of defect clearance

The defects register and the relevant responses in dealing with them shall be monitored by the CA to establish whether the number of defects is deemed excessive and if steps need to be taken to improve performance.

1008003 Inspection before concealment

Whenever work requiring inspection or testing is subsequently to be concealed, 7 days' notice shall be given to the CA so that inspections may be made or tests witnessed before concealment.

Failure to give due notice may necessitate the uncovering of the work and reinstating it at no extra cost or claim or extension to the programme or allowance for delay.

Record drawings of any services to be concealed shall be issued to the CA at the time notice is given.

1009004 Workmanship and materials

All materials, equipment and workmanship shall be of the best quality and in accordance with the specification and drawings.

All equipment and materials to be installed shall be new unless otherwise indicated.

All equipment shall be installed in accordance with the manufacturer's written instructions and recommendations.

All materials considered by the CA to be unsound or not in accordance with the specification shall immediately be removed and properly replaced to the satisfaction of the CA at no additional cost.

All work carried out imperfectly or with faulty materials must be immediately removed and properly replaced to the satisfaction of the CA at no additional cost.

Where manufactured items are not specified by name submit with the tender all necessary details of proposed items. The CA shall approve these items before their use is permitted.

1009000 MANAGEMENT OF THE WORKS

1009001 Site staff

Appoint a fully qualified engineer-in-charge / co-ordinator (or one mechanical and one electrical which is most suitable for the size of the project – to be agree with the CA) to ensure constant management and supervision of the Works for the duration of the contract.

The person(s) shall not be a site operative and shall have full authority to act in connection with the contract Works and communicate at all levels. This person(s) shall be available either part-time or full-time, whichever is most suitable for the size of the project as agreed with the CA.

Nominate an engineer who will be responsible for all drawings and technical information production.

Curriculum Vitae of all key staff shall be submitted with the tender documents. Any change made to such appointments shall be agreed with the CA and maximum possible notice shall be given.

If the CA is of the opinion that any member of the site staff has been guilty of a serious breach of his duties, he may by notice require that person to be replaced within two weeks of the notification.

1009002 Design management

Employ a design manager throughout the design process who shall have the full authority to make decisions. The design manager shall be suitably qualified to the satisfaction of the CA.

The design manager shall attend all design team meetings as required and be a participating member of the overall team during the development of the design

Once construction has commenced the design manager shall be involved until such time as all the production information has been completed and the contract Works are generally under construction.

Appoint the appropriate staff and necessary skills to undertake the design activities to the satisfaction of the CA.

Curriculum vitae of all key design staff shall be submitted with the tender.

Any change made to the appointment of design staff shall be agreed with the CA with maximum notice being provided.

Throughout the design stage be actively involved with the Employer's design team

Undertake and prepare any such design information required by other design team members to enable their element of the work to be detailed.

During the design and production information stages the CA will monitor by such means considered necessary the performance in the development of design and in the production of the detailed design and co-ordination drawings.

Should any part of the design not meet the required standard of the CA then modify and re-issue such work to the required standard at no additional cost or delay to the programme.

On completion of the contract design stage activities and prior to commencing the production information submit to the CA a statement of compliance that the design of the systems will meet the specification design and performance intent.

Submit a statement to the CA signed by a "competent person" prior to commencement of works on site that the systems can be properly prepared and commissioned and agrees with the intent of the design.

1009003 Programme

Within 2-weeks of the award of the contract provide a detailed programme produced by means of bar charts and full network analysis if so requested, clearly illustrating how the overall programme will be achieved within the contract period stated elsewhere, in particular identifying and if necessary justifying the following:

1. The latest dates for release of final information required from the CA.
2. The period required for the production, approval and issue of builder's work information, co-ordination, installation and shop drawings.
3. Allow adequate time for the production of drawings and builder's work information and for the subsequent checking and approval of same by the CA. The actual activities of production, adjustment, resubmission and review must be identified and a blanket time allowance will not be acceptable.
4. The period required for the testing and commissioning of the services. Separate testing and commissioning activities must be identified and a separate programme prepared.
5. The period required for operating the systems, load simulation tests, final adjustment, environmental testing and instructing the Employer's staff.
6. The period required and latest dates for the production, approval and issue of record drawings and operating and maintenance instruction manuals.
7. The periods required for each phase and engineering service on a floor by floor or zone by zone and plant room by plant room basis.
8. The proposed order dates manufacturing period and proposed delivery to site for each item of major plant to be clearly defined.
9. Any long delivery items shall be identified within one month of appointment and a detailed method statement prepared to schedule the action to ensure the delivery to site in adequate time to meet the contract requirements.

All information required above shall be agreed with the CA before inclusion in the proposed programme.

1009004 Progress

Ensure the Works programme is maintained up to date and redraft, without delay, in any circumstance arise that affect the progress of the Works and submit to the CA.

Provide progress reports to the CA every 2-weeks in addition to any other information required under the contract conditions.

Progress reports shall include, but not limited to, the following information:

1. Date of order and delivery of all major plant and equipment.
2. Materials and equipment on site or installed.
3. Site labour employed.
4. Activity breakdown indicating target percent progress and actual percent progress for each activity monitored against the contract programme.
5. Latest schedule of information required indicating required / received dates and highlighting critical path items.
6. Status of utility services with connection dates for each service.
7. Latest progress indicated on a copy of the programme. The programme shall include a base line activity bar for each activity and a separate progress bar to each activity bar
8. Any proposed alteration to the programme. Alterations shall be identified clearly prior to the activities being undertaken and shall be in accordance with the contract.
9. Copies of snagging/defects lists verifying that inspections are being undertaken.

Record progress of the Works weekly on a copy of the programme.

Maintain a set of the latest drawings, which shall form the basis for the record drawings, marked up as the works progresses. These shall be available for inspection by the CA at any time.

If at any time the execution of the Works falls behind the contract programme formulate corrective measures and notify the CA of these intended measures prior to their being adopted.

1009005 Ordering

Orders for plant, equipment and materials, as required, shall be placed to maintain the necessary progress of the Works. If requested provide copies of such orders to the CA within one week of request.

Notify the CA of any discrepancies in sufficient time so as not to jeopardise the contract programme and allow any instructions to be issued and implemented.

Prior to placing orders, be satisfied that all orders fulfil the requirements of the contract documentation. This shall include, but not limited to:

1. Performance and technical criteria
2. Compatibility between items of plant and systems
3. Dimensional co-ordination between building fabric, structure, items of plant and other engineering services

No claims will be accepted as a result of failure to be properly satisfied to these requirements.

Prepare an ordering schedule for submission to the CA that shall indicate the following data:

1. Item of material or plant
2. Manufacturer
3. Date of order and reference number
4. Acknowledgement of order and reference
5. Delivery period quoted
6. Date required on site
7. Off site testing date
8. Allowable programme float
9. Date delivered to site

Update and modify and submit the ordering schedule on a regular basis as agreed with the CA. Indicate on the schedule any possible problems and when delivery to site has been achieved.

1010006 Continuity of the works

No undertaking is given that the works will necessarily be able to proceed continuously and no claim will be entertained for discontinuity of work due to the necessity to conform to the contract programme.

1010000 SUBMITTALS AND APPROVALS

1010001 Submittals

The CA shall review all drawings and manufacturers details prior to any orders being placed.

The final details including all technical aspects and calculations where applicable shall be submitted in a clear, definable and easily read format with the specified technical details, notes and performance data clearly shown in the English language. Where drawings are to be examined the manufacturers' details shown on the drawings must have been previously reviewed or only partial approval/comment will be granted.

Submit a separate compliance statement for each item of plant or equipment identifying all technical details and performance characteristics and that required to be achieved as specified.

All reviews of submittals will be carried out in the offices of the engineer, Lakes Join Grandly Ltd, and include for all costs and make all necessary arrangements for reviews of submittals to be undertaken in this manner. All meetings in this respect shall be held in the offices of the engineer, Lakes Join Grandly Ltd. Agree with the CA where samples of materials offered for review are to be sent.

The drawings, calculations and submittals shall be issued progressively as agreed in advance with the CA for review.

Each package shall contain all drawings, design calculations, support information, method statements, manufacturer's literature, builder's work information, etc necessary to facilitate an independent review. All documents (excluding drawings) submitted for review must be adequately bound.

All correspondence related to the examination and review procedure shall be directed through the office of the CA.

Unless stated otherwise elsewhere allow 21 working days from the date of receipt by the engineer for review or comment or otherwise on all submittals.

1010002 Review of submittals

The CA will examine the submittals for compliance, in principle, with the design intent.

Such examination shall not relieve any responsibilities and obligations under the contract.

Examination of any submittal by the CA shall not mean that the CA is responsible for the correctness of the drawing or submittal or its suitability for purpose. These responsibilities shall remain as defined elsewhere and as the contract.

The drawings, calculations and submittals shall be issued progressively as agreed in advance with the CA to facilitate examination.

Allow adequate time in the programme for submittals with due allowance for incorporation of comments and resubmission in order not to cause delays.

Each package shall contain all drawings, design calculations, support information, manufacturer's literature, etc necessary to facilitate an independent review. All documents (excluding drawings) submitted for examination must be adequately bound.

All documents shall be clearly identified with a 'status' during the course of the project.

The following categories shall be used:

1. **Preliminary** - Submittal presented for informal comment as appropriate. Any comment, or lack of comment, is not to be construed or implied as giving approval.

2. **Information** - Submittal presented for information only and no comments required
3. **For Review** - To be reviewed and examined by the CA
4. **Construction** - For construction purposes

Revised items on drawings shall be indicated by 'clouds' around the changes and annotated with a revision number/letter.

All drawings shall require the approval of the installer's design manager to verify that the drawing has been developed from an approved design and that the information does not conflict with the requirements of other design disciplines.

All documentation submitted shall be accompanied by a certificate indicating that it has been checked and approved by the installer's design manager.

Only drawings that have been reviewed, and incorporate the comments by the CA may be progressed to 'Construction' status. Should it become necessary to revise the drawing its status must be changed to *'For Review'* and re-submitted.

On receipt and examination of any submittal the following conditions shall apply:

A Reviewed. Fabrication, manufacture or construction may proceed

B Reviewed. Fabrication, manufacture or construction may proceed subject to incorporation of comments indicated. If compliance with the comments cannot be achieved amend and re-submit.

C Rejected with or without comments. In this case the submittal does not comply and is to be re-submitted after correction.

Where drawings and submittals are reviewed subject to comments indicated these comments shall be incorporated immediately and re-submitted to the CA prior to issue for construction.

Where drawings are revised and updated during construction these shall be issued to the CA for examination of the revision only, the revision being clearly marked.

Builder's work information and installation drawings shall not be reviewed in detail but shall be examined by the CA for general suitability.

Record drawings are to be prepared as the Works progress and shall be examined in the same manner as stated above unless stated otherwise. Allow 20 working days from receipt by the Engineer for review and comment.

1010003 Mistakes in submittals

Be responsible for any error, discrepancy or omission in any submittal, presentation or drawing prepared or where others have prepared these for submittal. Responsibility will not be relieved whether or not such submittal has been presented to the CA and examined and/or approved and/or issued on a CA instruction.

The said indemnity shall be subject to the proviso that such error, discrepancy or omission is not due to any inaccurate data, drawing or information provided by the employer or by the CA on his behalf.
Reimbursement will be sought for any abortive expenditure that the Employer, CA and/or other trades and disciplines may incur in placing reliance on any such error, discrepancy or omission.

1010004 Schedule of drawings and submittals

Within one month of the contract appointment prepare a drawing schedule of all proposed drawings and submittals required for comment. The schedule shall indicate as a minimum the following information:

1. Drawing number and revision number
2. Drawing title and service
3. Scale
4. Latest date required on site and/or for manufacturing purposes
5. Date required for final comment
6. Date for submission for comment
7. Date of commencement of drawing production

As agreed with the CA revise and update the drawing schedule as necessary on a regular basis during the contract period.

In planning the production of drawings and other submittals take into account the time required for:

1. Submission to the CA
2. Examination by the design team
3. Alterations and re-submission in the event of the initial submission not being accepted
4. Final issue for construction purposes

Indicate the full extent of all submittals required to be submitted for comment. The submittals shall be grouped so as to support the main issue of drawings for a particular part of the building or building engineering service.

Incomplete submittals will not be examined until fully re-submitted, as they will be considered inadequate and misleading.

1010005 Calculations

All calculations produced in respect of design responsibilities must be co-ordinated and presented in a logical format that can be easily understood.

All calculations shall be prepared to a recognised and agreed format and must be indexed.

The use of computer programs in the preparation of designs shall be carefully controlled. All software programs shall be verified and their use agreed with the CA prior to commencement of design tasks.

Software used in calculating the energy performance of buildings, as required under Part L of the Building Regulations, shall be as approved by DCLG and agreed with the CA prior to commencement of use.

Where unverified software is used its use must be declared and the initial outputs justified by full and complete hand calculations.

Calculations that are preliminary in nature, i.e. do not form part of the final submittal, are to be referenced independently and clearly indicated 'Preliminary'.

Submittals shall clearly state the methodology, formulae, design criteria, assumptions and all design margins used in the calculations.

Where necessary calculation sheets shall be accompanied by an annotated layout drawing identifying terminals, fittings and the particular sections of ductwork or pipework.

Each calculation sheet, drawing or schedule shall clearly identify the originator, date of production, checker (who signs or initials) and date of check.

Each set of calculations shall further require the approval of a Chartered Engineer to verify that the design is in accordance with the specification and design intent.

Allow at least 21 working days from date of receipt by the engineer for examination of the calculations and submittals.

Incomplete submittals will not be examined until fully re-submitted, as they will be considered inadequate and misleading.

The costs for the preparation of all necessary calculation shall be included in the tender return.

1010006 Equipment performance details

Submit details of the equipment selected and approved for inclusion into the Works. The format and content of the information to be submitted shall be as agreed with the CA.

The details shall include but not limited to the following information :

1. Plant item description, reference identification and serial number
2. Electrical input rating - *kVA, Volts, Phase*
3. Operating mode
4. Starting characteristics - *starter type, current, starts/hour and starting time*
5. Performance characteristics - *full load current and power factor*
6. Operating noise levels
7. Operating and shipping weight
8. Technical performance

1010007 Manufacturers technical data

The tender drawings have been prepared based on the current catalogue information of the equipment specified elsewhere.

Revisions or modifications of the physical characteristics of the equipment sometimes occur between the published catalogue information and the final information issued on the manufacturing drawings. When such revisions or modifications arise incorporate these and their effects on other parts of the Works onto the installation drawings and where necessary the final builder's work information.

Review the manufacturer’s references at the earliest opportunity and bring any anomalies to the attention of the CA in writing.

No extra cost or claim or extension to the programme or delay will be allowed for such modifications to the drawings or the Works as a result of such manufacturing changes.

1010008 Equipment and plant performance guarantees

Where equipment and plant performance data and duties are identified in the specification check and ensure that the equipment (where the manufacturer is named and/or a figure number is quoted) is capable of the stated duty or performance in all respects.

Obtain a written undertaking from the selected and approved manufacturer that all aspects of the defined specification will be achieved and submit to the CA prior to the installation of the equipment and plant.

More than one clause of the specification may cover the total performance of the equipment and therefore ensure that the supplier obtains or has seen all sections of the specification prior to giving the written guarantee of performance.

1010009 Technical information and queries

Complete and submit a technical query request to the CA where clarification on any technical issue is required.

For the purposes of clarity the use of raising technical query requests is intended to foster a pro-active approach to dealing with genuine queries. In this respect the issue of a technical query shall include the installer’s suggested solution to the query for the consideration of the CA.

If in the opinion of the CA a technical query is deemed to be inadequate in any way the CA shall have the sole discretion to reject the technical query until such time as adequate information is provided by the installer.

No claims for additional costs and/or extension of time shall be considered through the lack of information provided by the installer and/or the rejection of technical queries.

Ensure that technical query sheets are raised at least two weeks prior to the requirement for a response.

Prepare a schedule to record the progress of technical queries and ensure it is maintained up to date. An agreed referencing system shall be adopted for all technical queries and each query shall have the following information:

1. Unique reference
2. Brief description of query
3. Date raised
4. Date response required

1010010 Preparation of drawings

Prior to preparing any documents agree with the CA a document numbering system.

All drawings for the works shall be prepared on a computer aided draughting system AutoCAD or compatible, producing drawings in standard .dwg format.

The AUTOCAD software used to produce drawings shall be approved prior to commencement of drawing production.

Where a building information modelling (BIM) system is utilised, Revit or compatible, all derived files will be supplied in .dwg, .dwf and .xls compatible format as appropriate.

All drawings and models will maintain a common base coordinate point and rotation angle to enable reconstruction of models for co-ordination overlay.

Scales used on drawings shall be selected from industry standard scales to clearly convey the proposals with legible annotation.

Drawing units are to be metric with one unit being one millimetre.

Drawings sheets shall be “A” size to ISO 216 standard and include a title block, typically in the lower right hand corner.

As a minimum drawing title blocks will include company name, project name, drawing title, drawing scale, drawing number,drawing revision and date.

All drawings shall include a layering system to industry recognised classification (BS1192 Part 5, Uniclass or similar industry standard).

All drawings shall be read in conjunction with the structural engineering and architectural drawings and ensure that work is being carried out in accordance with the latest issue of the relevant drawings, assuming authority has been issued.

Published drawings will include all bound externally referenced data and be audited and purged of extraneous data prior to distribution.

The medium for transfer of information shall be high quality CD-R. with two disks being supplied for each batch of drawing data.

A pen plot of the drawing is to be supplied with the CD, this ensures that they have a plottable drawing which if plotted with the correct pens produces a workmanlike drawing.

The CA will decide on the medium to be used which will be film, tracing paper or plain paper dependent upon the type of drawing being commissioned or the longevity required. Electronic plots may also be provided in .dwf format or .pdf format as agreed with the CA.

Scales used on drawings shall be selected to convey clearly the proposals.

Ensure the notation on all documents produced follows the same conventions as the tender documentation. Agree additional notation with the CA before preparing any documents.

1010011 Revisions of drawings

Where revisions take place either under the authority of a CA instruction, or by written agreement with the CA or when revised architectural, structural or services information is issued, all drawings shall be modified accordingly and shall be re-issued for construction purposes subject to examination by the CA. The issue of revised drawings shall be in accordance with and with regard to the agreed programme for construction and where time is available re-issues shall be grouped together, as agreed with the CA.

Providing all revisions are properly incorporated into the drawings and the final installation is correct according to the drawings, then the final issue of these drawings may be used in conjunction with the draft set of marked up prints kept on site, as the basis for the record drawings.

1010012 Method statements

Submit method statements to the CA prior to commencement of the contract works.

Provide the following method statements in addition to those stated elsewhere:

- Health and safety statement to include:
  a. Management procedures.
  b. Any significant and unavoidable risks that might arise as a result of executing the Works.
  c. An outline of the health and safety procedures to be undertaken to safeguard the operatives and of any person who may be affected by the Works.
  d. A copy of the company's health and safety policy document including risk assessment procedures
  e. Accident records for the last five years
  f. Details of any Health and Safety Executive enforcement action
  g. Details of staff responsible for health and safety on this project with details of their qualifications and duties.
- Management procedures to be adopted for the project.
- Managing and resourcing of design duties and responsibilities including design capability.
- Commissioning and testing procedures and management.
- Quality control management and procedures. The method statement must:
  a. Indicate the quality control programme
  b. Demonstrate compliance with the contract in regard to materials and workmanship.
  c. Demonstrate the establishment of standards by means of sample installation and submission of samples prior to installation.
- Statement outlining the management team, stating the definition of each person's role, and the commitment to the project including:
  a. The curriculum vitae and references for each of the key personnel that will be used on the project.
  b. A line management diagram starting at the site supervisors and rising through the management levels.
  c. Details of both site and office based staff.

1010013 Samples

Furnish free of charge as stated or as may be required by the CA such samples of material and workmanship proposed to be used in the Works.

Samples shall include all alternative finishes available if required.

If the samples submitted do not, in the opinion of the CA, meet the requirements or fail to satisfy the terms of the specification, the CA may obtain samples elsewhere of the articles or materials from the same source without prejudice to their right to reject part or all of such articles or materials should they not prove equal in all respects to the samples they obtain or provide.

In the case of articles of special construction, working drawings may be temporarily substituted for the samples, if preferred. Such drawings when approved will be retained by the CA until the articles concerned are supplied, as a sample.

The samples submitted and approved, shall remain the property of the Employer until the completion of the contract.

Equipment shall not be placed on order until the approval of the CA has been obtained.

Samples shall be available for inspection at site and held on site for future reference for the duration of the contract.

1010014 Form and number of submittals to be provided

All submittals shall be issued to the CA

The number of copies and format of information to be provided shall be as follows:

1. Initial copies for comment shall be in print format and CAD format
2. Number of initial copies in print format for comment to be 2No
3. Final copies for comment shall be in print format and CAD format
4. Number of final copies in print format for distribution to be 4No
5. Initial copies of record drawings for comment shall be in print format and CAD format
6. Initial copies of record drawings in print format for comment to be 2No
7. Final copies of record drawings shall be in print format and CAD format
8. Final copies of record drawings to be 2No

1011000 OBLIGATIONS AND RESPONSIBILITIES

1011001 General

The section outlines the responsibilities and obligations to be undertaken relating to the Works. The listing is not exhaustive and does not relieve any responsibilities stated or implied within the contract documents or elsewhere in the specification.

Undertake responsibility for all works detailed in the contract, engineering specification and shown on the drawings.

Detailed design responsibilities are as stated elsewhere, in addition to those activities normally undertaken through the custom and practice of the industry.

Comply with the obligations as designers under all Health and Safety Regulations.

The schedule below outlines the responsibilities and obligations to be undertaken relating to the engineering services works. The listing is not exhaustive and does not relieve any responsibilities stated or implied within the contract documents or elsewhere in the specification.

1011002 General requirements

1 Undertake specific detailed design tasks as indicated elsewhere in the specification

2 Complete the design development.

3 Provide the following drawings as defined elsewhere in the specification:
- Detailed design drawings
- Co-ordinated working drawings
- Installation drawings
- Manufacturer's drawings
- Record drawings

4 Incorporate details provided by others into any design development and installation information.

5 Fully re-evaluate and take full responsibility for all parts of the design and building elements that may be affected by acceptance of alternative plant selections

6 Undertake the responsibility for resolving final spatial co-ordination.

7 Modify the final detailed spatial co-ordination for approved alternative equipment or materials.

8 Undertake the co-ordination of the engineering services, with each other and with the building structure and fabric.

9 Undertake all on-site co-ordination with all other trades, disciplines, manufacturers and suppliers.

10 Carry out all on-site co-ordination with all other trades, disciplines, manufacturers and suppliers

11 Undertake the role of lead co-ordinator and agree principles of co-ordination with all parties concerned. Incorporate details provided by others into the design

12 Carry out final detailed location and dimensioning of second fix equipment based on architectural information

13 Provide all necessary co-ordination and installation drawings in order that the Works can be planned, installed, commissioned and maintained

14 Prepare detailed electrical wiring diagrams of all equipment supplied showing all interconnections between equipment to enable all necessary wiring to be undertaken

15 Notify the necessary Statutory Authorities (Building Control, Fire Officer, Environmental Health etc) in respect of all tests and demonstrations required. Arrange all necessary attendance, documentation to ensure full approval.

16 Demonstrate that all plant and equipment incorporated into the works can be safely and easily maintained in compliance with current legislation.

17 Provide compliance statements for all selected plant and equipment demonstrating full compliance with the specification prior to order and commencement of the Works. Highlight for review all non-compliances.

18 Prepare such reports, calculations and details as required for submission to any appropriate authority including the co-ordination of such information by suppliers, specialists, etc needed to be included in any submission.

19 Supply, deliver to site, unload (including lifting and hoisting), store, protect and co-ordinate movement of all plant, equipment and materials required for the contract works

20 Inspect all plant, equipment and materials as delivered or where specified at the manufacturer's works. Inspection and/or tests to be carried out at the manufacturers' works jointly with the CA for equipment as stated elsewhere. Include for the travel and other expenses of the CA for the inspection and/or tests to be carried out at the works

21 Fix and install correctly all plant, equipment and materials and ensuring that all associated works are correctly executed.

22 Prepare construction programmes for the Works as stated elsewhere and for design activities.

23 Obtain final quotations for incoming services based on final agreed building loads.

24 Provide suitable accommodation, workshops, stores and clearing away on completion

25 Fix and install correctly all plant, equipment and materials and ensuring that all associated works are correctly executed

26 Check software engineering and programming is completed so that systems function in the prescribed manner.

1011003 Building Regulations Part L

1 Advise on the impact of any changes during the course of the Works that may result in the final CO_2 Buildings Emissions Rate not achieving compliance.

2 Assist and collaborate with others in liaison with Statutory Authorities with respect to Building Regulations approvals and compliance. Prepare supporting documentation.

3 Evaluate and assess the impact of all proposed alternative equipment or materials on the final 'as constructed' CO_2 Buildings Emissions Rate not achieving compliance. Submit a report to the CA.

4 As instructed by the CA prepare a report in consideration of any additional works associated with the Works that may be a consequence of the 'as constructed' CO_2 Building Emissions Rate for Part L not achieving compliance. Identify costs, programme and method statement for executing the additional works.

1011004 Builders work

1 Check the provisions for, and adequacy of builder's work information previously issued prior to the award of the contract

2 Check the spatial requirements and adequacy of builders work information previously issued by others for utilities works.

3 Seek utility company comments on the spatial requirements and builder's work associated with the provision of incoming services

4 Provide final builders work details based on the installation, manufacturing and shop drawings to facilitate the installation of the works. To include fully dimensioned drawings showing both size and position of builder's work making due reference to the structural engineering and architectural final dimensioned detailed drawings.

5 Detail all access requirements including access to false ceilings and ducts for maintenance. Provide fully dimensioned and annotated drawings

6 Undertake the redesign of the associated builder's work for approved alternative equipment or materials which subsequently varies the works in any way whatsoever.

7 Undertake the detailed design and location of brackets and supports. Details of all types of brackets and supports including fixing details and load calculations shall be submitted to the CA for comment prior to installation.

8 Undertake the design of all steelwork, brackets, hangers, clips etc., plinths and inertia bases necessary for support of plant and services (unless indicated otherwise)

9 Select and detail sleeves, inserts, frames, fixing anchors etc., and any other items required to be cast or built into the structures by others, including coordination of positions.

10 Undertake the detail design and co-ordination of all access platforms, access covers, gratings, ladders, stairs, rails and protecting elements required for future maintenance and operation of plant/equipment. Provide fully dimensioned and annotated drawings

11 Undertake and detail all fire stopping and sleeving systems for the Works where they pass through fire compartments together with the installation of fire barriers where a fire rated partition is penetrated.

12 Design of details for the weatherproofing of all services passing through external elements of the building.

13 Detail the final requirements for access to ceiling voids and builder's work ducts for maintenance and operation

14 Undertake and detail all acoustic stopping associated with the Works

1011005 Mechanical

1 Undertake the detailed design and final location of drain and vent points and pipework gradients

2 Design of adequate provision for movement of services and systems due to thermal expansion and contraction, hydraulic pressures and building movement, including cold draw calculations and proving of expansion loops in lieu of expansion equipment.

3 Undertake the detailed design and location of expansion anchors and guide locations. Details of all expansion anchors and guides, including fixing details, load and thrust calculations shall be submitted to the CA for comment prior to installation.

4 Final locations of valves, dampers and required access requirements based on the final equipment selection and co-ordinated installation drawings

5 Calculate all final fan and pump system resistances based on the final equipment selection and co-ordinated installation drawings

6 Undertake the detailed design and sizing of refrigerant pipework between items of equipment provided under the contract works based on the final equipment selection and co-ordinated installation drawings

7 Calculate system water capacities and quantities of chemical additives based on the final equipment selection and co-ordinated installation drawings

8 Design of all necessary temporary facilities for flushing, commissioning, etc

9 Undertake the final sizing, selection and determination of final locations of commissioning sets including any proportioning of mains losses, etc based on the final equipment selection and co-ordinated installation drawings

10 Final selection of system(s) pressurisation units and expansion vessels based on the final equipment selection and co-ordinated installation drawings

11 Final sizing of sections of ductwork between terminal units and diffusers to ensure the specified acoustic criteria and duct velocities

12 Final selection and location of control dampers, control valves, etc to achieve the specified function and to suit the characteristics of items served and final system configurations based on the final equipment selection and co-ordinated installation drawings. To include access requirements.

13 Final selection and location of control valves to suit pipework and authority of controls based on final installation drawings

14 Final design of flues to include the incorporation of the requirements of the respective manufacture, building control, environmental health officer and current legislation eg clean air act.

15 Determining the extent and design of trace heating systems for frost protection of relevant services and temperature maintenance on domestic hot water systems

16 Final detailing and design of fire rated ductwork systems complying with testing standards and the obtaining of statutory approvals

17 Final detailing and confirmation of the location and sizes of duct connections to external louvers

18 Design and selection of sound attenuation equipment to satisfy the particular performance requirements of the specification and the spatial allowances based on final plant/equipment selection and final co-ordinated installation drawings

19 Design of final acoustic requirements or modification of equipment to attain the particular performance requirements of the specification.

20 Final selection of all anti-vibration mountings to suit the particular application of the mounts

21 Undertake the redesign of the final acoustic requirements associated with approved alternative equipment or materials which subsequently varies the Works in any way whatsoever.

22 Design of sprinkler installations including provision of hydraulic calculations. Undertaken by an approved designer and all in accordance with LPC Rules and legislative requirements.

23 Provide a report confirming that the results of the leakage tests are in compliance with the specified ductwork leakage requirements.

24 Design of sprinkler installations including provision of hydraulic calculations. To be undertaken by an approved designer and all in accordance with LPC Rules and legislative requirements.

1011006 Automatic Controls/BMS

1 Undertake the detailed design of automatic controls systems insofar as it is required to meet with the operational, functional and spatial requirements of the specification.

2 Responsible for the full compatibility of the plant and equipment with the controls system and specified function.

3 Prepare detailed BMS point schedules, wiring schematics, control panel labelling details and equipment schedules for the complete Works

4 Design and incorporation of all interfaces (including relays or other devices or modifications to hardware and/or software)

5 Undertake the dimensioning and final installation details of automatic control panels to suit the detailed requirements of the agreed supplier of the controls equipment including provision of safe operating and maintenance clearances and ensuring acceptable cable entries/exits in the final location

6 Final locations of test points, control sensors, detectors, thermostats, etc

7 Sizing of cable terminations on all items of equipment

8 Preparing detailed electrical wiring diagrams of all equipment supplied showing all interconnections between equipment to enable all necessary wiring to be undertaken

9 Capacity, location, routes and design of electrical containment systems including conduit, trunking, tray etc associated with the automatic controls and BMS

10 Verify all cable sizes, voltage drops, discrimination and fault handling of cables based on the installation drawings, selected plant equipment and actual installed cable lengths. For the purposes of clarity, the BMS/controls specialist shall include as part of their tender the costs for providing cable sizes based on this clause. No additional costs will be allowed for changes in cable size as a result of action due to this clause.

11 Ensure that software engineering and programming is completed and undertaken so that systems function in the prescribed manner

1011007 Electrical

1 Selection of fuse sizes installed in plug tops appropriate for the rating of the connected equipment

2 Design of cable or cable containment terminations on to electrical equipment

3 Dimensioning and final installation details of electrical switchgear including provision of safe operating and maintenance clearances and ensuring acceptable cable entries in the final location

4 Undertake the detailed design of earthing and bonding requirements for electrical engineering services, mechanical engineering services, architectural and structural elements requiring earthing and bonding

5 Design of fixing, connections and bonding details as required for final installation of lightning protection systems

6 Check that cable size selections as specified are not invalidated by the selection of alternative routes during installation or selection of alternative manufacturers.

7 Undertake the detailed sizing, location, routes and design of all electrical containment systems including trunking, conduit, tray, etc and supporting structures to include fire stopping provisions.

8 Verify cable sizes, voltage drops, discrimination and fault handling of cables based on the installation drawings, selected equipment and actual installed cable lengths for specialist systems eg CCTV, access control,etc. For the purposes of clarity, the installer shall include as part of their tender the costs for providing cable sizes based on this clause. No additional costs will be allowed for changes in cable size as a result of action due to this clause

9 Undertake the final detailed design of the fire alarm system including component and cabling requirements to meet with particular manufacturer's recommendations, the engineering specification and requirements of Statutory Bodies, standards and codes

10 Undertake the final detailed design of the lightning protection system in accordance with the engineering specification requirements and current code of practice and standards.

11 Design of fixing, connections and bonding details as required for final installation of lightning protection systems.

12 Undertake a study to determine compliance with G5/4 and IEC 61000-2-4 (electromagnetic compatibility). Assimilate all relevant technical data including the final selected equipment from all parties prior to the study being undertaken. Issue a report on the study findings in due time to suit the requirements of the programme for the Works.

13 Provide a report confirming the final metering strategy as installed.

14 Verify spatial requirements, routes and anchor points for cable pulling.

15 Verify cable sizes, voltage drops, discrimination and fault handling of cables based on the installation drawings, selected equipment and actual installed cable lengths for all necessary systems

16 Undertake a study to determine compliance with G5/4 and BS EN 61000-2-4 (electromagnetic compatibility).
- Assimilate all relevant technical data including the final selected equipment from all parties prior to the study being undertaken.
- Issue a report on the study findings in due time to suit the requirements of the programme for the Works.

1011008 Commissioning

1 Test, commission, regulate and set to work the Works

2 Design all necessary facilities required for setting to work commissioning and testing of the completed installations

3 Appoint an independent specialist commissioning contractor responsible for the testing and commissioning

4 Ensure that the commissioning requirements are compatible with any project restraints concerning sectional handover/ phasing.

5 Review all designs to ensure that systems are commissionable. Provide a statement on appointment and prior to commencement of the Works. Highlight for review by the CA any considerations in respect of commissioning.

6 Incorporate into the systems design the essential components and features necessary to enable the proper preparation and commissioning of the building services.

7 Produce comprehensive commissioning method statements including procedures, logic diagrams and risk assessments for the pre-commissioning checks, setting to work, commissioning, system proving and environmental testing of the Works

8 Produce flushing, chemical cleaning and water treatment method statements, logic diagrams and programme for integration into the building contractor's construction, commissioning and finishes programmes.

9 Produce a detailed commissioning programme for integration into the building contractors' construction and finishes programmes.

10 Establish procedures with all parties to allow the demonstration of normal, emergency, shutdown and standby mode operation of plant and systems.

11 Provision of all necessary facilities to enable tests to be witnessed and inspections carried out including all necessary instruments and recorders to monitor systems during the commissioning and environmental proving period.

12 Produce record pro-forma documentation relating to the commissioning and testing of plant and systems

13 Co-ordinate the activities of all specialised personnel, including manufacturer's together with providing necessary attendance

14 Measure and reconcile both internal and external noise levels to verify compliance with the design criteria

15 Ensure all certification is attained and witnessed as necessary for inclusion in the record documentation

16 Maintain a log of all significant activities during the testing, commissioning and system proving process

17 Ensure that all plant and system settings are recorded

18 Provide a report signed, by a competent person confirming, prior to installation that all system designs can be commissioned

19 Provide and submit a report for every test, demonstration, balance or commissioning activity witnessed, together with an engineering appraisal on the performance, either on or off-site.

20 Provide a final commissioning report detailing the results of the commissioning and commenting on the performance of systems signed by a competent person. The report to confirm that each installation is correctly tested and commissioned and achieving the specified performance.

21 Demonstrate that the equipment is capable of the performance and method of operation specified

22 Demonstrate that the overall and complete systems perform correctly in the required manner and as intended by the specification.

23 Ensure that the commissioning and testing complies with the requirements of the Building Regulations Part L and that the procedures follow the guidance and recommendations of the documents stated in the Regulations. Prepare and submit all necessary submissions as required to obtain compliance.

1011009 Handover

1 Prepare log book(s) in accordance with the requirements of the specification and Building Regulations

2 Appoint an independent specialist author for the production of operating and maintenance manuals. Identify four specialists as part of the tender return.

3 Prepare operation and maintenance manuals in accordance with the specified requirements.

4 Ensure that information needed for inclusion in the operating and maintenance manuals is obtained as the works progress. Identify individual sources of information.

5 Produce record drawings. Modify the record drawings as the works progress so that all alterations from the installation drawings are recorded as work proceeds.

6 Modify and update operating details to reflect commissioning results.

7 Record all water, gas and electricity meters on completion of the works

8 Prepare planned preventative maintenance schedules for 12 months from practical completion

9 Instruct the Employer's staff in the use, operation and maintenance of the installations

10 Fully operate and maintain the installations in accordance with the Employer's normal occupational requirements prior to practical completion

11 Prepare a schedule of all spare parts require for the works including recommendations of any others not stated in the specification

12 Prepare a schedule of all tools require for the works including recommendations of any others not stated in the specification

13 Handover all tools, spares, keys, etc

1011010 During the 12 months after practical completion

1 Assess the need for and undertake fine tuning of the Works. Required visits will be as stated elsewhere in the specification.

2 Ensure that all plant and system settings are recorded following fine tuning activities

3 Programme and plan fine tuning activities in advance and agree. Prepare programme in advance and agree with CA.

4 Arrange for the relevant parties to be retained and appointed to provide input to fine tuning activities

5 Ensure that fine tuning activities are planned with regard to the health and safety of occupants and such that any disturbance to them is minimized

6 Provide a mechanism by which the Employer can provide feedback on the performance of the building both before and after fine tuning

7 Attended meetings to deal with issues arising from fine-tuning of the Works.

8 Ensure that BMS trend logs are maintained for the whole of the 12 month period and can be readily accessed by the CA.

1011011 Existing services

1 Remove the existing services as stated in the specification

2 Prepare method statement(s) for the removal of the stated existing services to include risk assessments, permit to work requirements, temporary works and methods of removal.

3 Prepare method statement (prior to commencement of works) for the maintenance of existing services.

4 Maintain all existing services during the duration of the contract including the provision of any additional work and materials necessary

5 Determine and define any physical site restrictions, constraints and hazards which may affect the undertaking of visual inspections, including health and safety matters, prior to commencement of the Works.

6 Identify special training requirements for surveys of existing installations

7 Survey the existing installations for adequacy, safety, condition, maintainability, hazardous substances/materials etc. Assess the general condition of each of the services, based on visual inspection, indicating any faults or defects found and recommended where further specialist investigation is required.

8 Survey the existing services installations to determine function, size, material, safety, maintainability and location with respect to existing structure and architecture

9 Determine the presence of deleterious materials relating to the services

10 Survey the existing structure and incorporate the survey data into the installation information. Include dimensional data, structural data and topographical data

11 Record survey information by amending the installation drawings and/or preparing new drawings

12 Identify any parts of the services, based on visual inspection, that do not appear to comply with current statutory regulations, codes of practice, or normal good practice.

13 Undertake an assessment relating to the prevention and control of legionella

14 Record survey information by amending the installation drawings and/or preparing new drawings together with necessary supporting detailed reports and photographic material

15 Advise on the requirement for any urgent works or required action as a result of non - compliance and any parts of the services installation found to be potentially hazardous.

16 Identify special training and other requirements that should be satisfied before commencement of the Works

17 Producing record drawings for the complete existing services

18 Survey the existing structure and incorporate the survey information into the installation information

1012000 LOCAL AUTHORITY AND BUILDING REGULATIONS

1012001 Statutory authority approvals

Make full and formal submissions to Building Control/District Surveyor at the earliest opportunity to ensure the approval of the Statutory Authorities for the proposed installation works.

Notify the District Surveyor, Building Control Officer and Fire Officer directly in respect of all tests and demonstrations relevant to life safety installations, and include for all necessary attendance, documentation, etc., to ensure full Statutory Authority approval of the installation.

Include for all fees and charges legally required under such Act of Parliament, Regulations or By-Laws in respect of the Works.

1012002 Authority notices

Documents requiring the Employer's signature shall be forwarded to the CA in time to meet the contract programme in order for the necessary test and supply arrangements to be made.

No additional costs or extension to programme shall be allowed due to reconnections, revisits etc by supply authorities or failure to programme the works.

1012003 Bye – laws notices

Observe and comply with the requirements of all Statutes and Bye-Laws and serve notices on the Authorities having control of the road surfaces before the same are broken up and likewise serve notices on the owners of sewers, drains, water, gas or other mains, electric cables, tramways and other services or things, which may in any way be affected by the execution of the Works. Inform all necessary parties when work necessitates such notices to be given.

1013000 HEALTH AND SAFETY

1013001 General requirements

Comply with the requirements of all relevant health and safety legislation and regulations including the Construction (Design & Management) Regulations (CDM) 2007 and the corresponding Approved Code of Practice.

Comply with all CDM procedures required by the CDM co-ordinator and the Principal Contractor.

Provide all necessary information to the Principal Contractor including any method statements in accordance with the requirements of the CDM Regulations prior to the commencement of works on site.

Provide relevant information about the works that might affect the health and safety of any person.

Allow for providing all necessary general health, safety and welfare facilities unless it has been specifically agreed that certain facilities will be provided by others.

Ascertain the sufficiency and accuracy of information provided by, or on behalf of, the Employer and advise where any additional information or clarification is required.

Where design activities are undertaken or there is involvement in the design of any elements of the contract works co-operate with and provide information to the CDM co-ordinator in accordance with the designer's duties under the CDM regulations.

Appoint a “competent person” on the site to manage health and safety during construction.

Ensure, so far as is reasonably practicable, that all persons employed on, or visiting, the site are adequately informed, instructed, trained, supervised and equipped such that they are able to carry out their duties without risk to safety or health.

Take all necessary steps to ensure that only authorised persons are allowed into any construction area.

Prepare all necessary information for the production of a health and safety file for the works in accordance with the requirements of the CDM Regulations and in the format defined by, or agreed with, the CDM Coordinator and/or Client. Ensure and coordinate the provision of information for the health and safety file by all sub-contractors, specialists and suppliers. Provide the health and safety file information in adequate time to allow this to be coordinated and handed over to the Client at practical completion of the works, unless otherwise agreed

1013002 Pre-construction information and construction phase plan

Comply with the requirements of the project health and safety pre construction information.

The health and safety information provided in the tender documentation or within the pre-construction information is limited to highlighting significant risks to health and safety identified during the design and is not intended to identify all health and safety risks with which a competent contractor should be familiar.

Produce the construction phase plan in accordance with the requirements of the CDM Regulations prior to the commencement of the works on site.

The development of the construction phase plan shall not be limited to those particular risks identified in the pre-construction Information but shall include consideration of all reasonably foreseeable risks. The plan shall include the arrangements for the management of the construction works and for monitoring compliance by all persons with the requirements of relevant statutory provisions.

The construction phase plan must be adequately developed, as far as is reasonably practicable allowing for any phasing of works, etc., in sufficient time to allow it to be submitted for approval prior to the commencement of any works on site. In the case of phased works the health and safety plan relating to the work content of any phase must be adequately developed and submitted for approval prior to the commencement of any work within that phase of the project.

Ensure that all sub-contractors are issued with copies of the pre-construction health and safety information including details of all identified significant hazards and relevant information prior to the submission of their tenders and that they price for compliance.

Ensure that all sub-contractors complete appropriate assessments of the risks to health and safety in respect of their works as required under the latest applicable statutory legislation, including The Management of Health and Safety at Work Regulations and the Control of Substances Hazardous to Health Regulations.

The construction phase plan shall be reviewed and revised as necessary in line with any information received or any changes in the requirements of the contract works. Any changes shall be promptly advised to all relevant parties.

Ensure, so far as is reasonably practicable, that all sub-contractors, employees and self - employed persons under your control who are at work on the construction of the project comply with the requirements of the construction health and safety plan.

1013003 COSHH Regulations

Comply with the latest Control of Substances Hazardous to Health Regulations.

Provide with the tender a method statement on the steps proposed to meet the requirements of the Regulations

Undertake COSHH assessments for all activities and substances provided or used on site to assess their potential health hazards. Copies of all relevant COSHH assessments must be issued to the operatives concerned and strictly monitored. Particular attention must be given to the use of glues and sealant.

Where the use of substances falling within the scope of the Regulations forms part of the contract works notify the CA in writing, together with the additional costs, if any, of use of non-hazardous alternative.

Ensure during the course of the contract works, and under all circumstances, that all substances falling within the scope of the Regulations are positively so identified at all times and that they are transported, handled, stored, used and disposed of in strict accordance with their manufacturer's/supplier's recommendations.

Where use of substances falling within the scope of the Regulations are required for the operation and maintenance of the completed contract works, ensure that suitable facilities are available for the on-site storage of such substances and that all necessary warning/instruction notices are provided at the point of their storage and use.

Provide any special protective clothing, eye protection and similar safety equipment for the operation and maintenance of the Works and in sufficient quantity for one year operation.

Undertake the necessary training of the employer's staff in the use, handling, storage, transport and disposal of the substances concerned prior to handover.

Ensure that the type, use and control of the substances have been fully and correctly identified in the operating and maintenance manuals/health and safety file.

1013004 Asbestos

No material or goods containing asbestos shall be incorporated in the contract works.

At practical completion of the contract works certify that no asbestos or asbestos related materials have been incorporated or by any sub-contractor employed.

1013005 Risks to health and safety

Submit a statement with the tender describing any significant and unavoidable risks which may arise as a result of carrying out the contract works and the measures proposed to safeguard the health and safety of operatives and of any person who may be affected by the contract works.

1014000 BUILDERSWORK

1014001 Builders work provided

Where major structural and/or architectural facilities or provisions, for engineering services may have already been indicated check that these are correct, satisfactory and adequate for the purpose and confirm same in writing to the CA within 2-weeks of the award of contract.

Where the preliminary builder's work facilities issued prior to the award of contract are not correct or insufficient advise the CA immediately and obtain further instructions.

No additional cost or time extension will be allowed for modifications to the Works due to failure to adequately check the existing or preliminary builders work facilities and provisions.

Revise, supplement and/or issue final information, drawings/details for the actual contract works requirements.

Where alternative equipment or materials has been offered that the CA has accepted and which subsequently varies the works in any way whatsoever, then undertake the redesign of the associated builder's work. No claim for additional costs or delay to the completion of the works will be allowed.

1014002 Builders work responsibilities

The requirements for and responsibilities with regard to builder's work items are in addition to that normally provided as is normal custom and practice in the building industry.

Confirm and amplify any information provided by the CA.

Provide the specified builders work drawings/details and issue same for construction in compliance with the agreed programme.

Provide all builders work information in sufficient time, including necessary approvals, to comply with the agreed programme requirements. No additional cost or time extension will be allowed arising from failure to comply.

Prepare all other necessary builders work drawings required for the execution of the works, making due reference to the structural engineering and architectural final dimensioned detail drawings. Drawings shall be fully dimensioned drawings showing both size and position of builder's work.

Provide all necessary supporting steelwork, brackets, clamps and fixings necessary for the complete installation.

Ensure that all items of works undertaken or materials provided under this contract, are included in the contract price, and also that any such item, including builders work information and materials supplied, are incorporated into the works in accordance with the agreed programme.

All materials provided for fixing by others shall be included in the contract works cost and supplied in accordance with the programme.

1014003 Marking out of builders work holes on site

If agreed with the CA, mark on site actual locations of minor non-structural holes through walls, partitions, floors etc and also chases in non fair-faced walls, etc for conduits, pipes and the like in preference to providing drawings of such builder's work requirements.

The CA shall inspect all marking out on site prior to work commencing.

Establish a method of working with the CA to ensure the works may proceed without hindrance.

The maximum size for a non-structural hole for marking on site shall be 150mm x 150mm

1014004 Structural steelwork

No structural steelwork shall be cut, drilled or welded without written approval from the CA prior to the commencement of the work and shall require application in writing with all necessary drawings/details.

Fixings to steelwork shall be of the clamp type.

All fixings to steelwork shall be of the correct size and type for the fixing load applied and the type shall be approved prior to commencement of the works.

1014005 Pre-cast concrete

Holes shall not be cut in precast concrete without written approval from the CA and under no circumstances cut holes in pre-stressed concrete.

1014006 Builders work drawings

Drawings to be provided shall be as follows:

- Details of all bases for plant formed in concrete, brickwork or blockwork to a scale of not less than 1:20
- Details of all attendant builders work, holes, chases, etc for conduits, cables and trunking etc and any item where access for a function of the installation is required to a scale of not less than 1:50
- Details of all purpose made brackets for supporting service or plant/equipment to a scale of not less than 1:50
- Details of all accesses into ceilings, ducts, etc at a scale of not less than 1:50
- Details of all special fixings, inserts, brackets, anchors, suspensions, supports etc at a scale of not less than 1:20
- Details of all sleeves, puddle flanges, access chambers at a scale not less than 1:20

Submit all necessary load and thrust calculations with drawings/details.

1014007 Scope of builders work

The following schedule states in general terms the requirements for and responsibilities with regard to builders work items in addition to that normally provided as is normal custom and practice in the building industry.

Work element	Work in this contract	Work by others
Pipe, duct and cable sleeves through walls, floors, slabs etc.	Supply and install all necessary sleeves of a suitable material and fire rating for the application.	Cut hole or form/cast hole for sleeves and provide lintel and then "make goo builders work around sleeves (after fin positioning) with cement or mastic materials as necessary all to the required fire rating / properties.
Puddle flanges	Supply all puddle flanges and hand-over to others for fixing	"Cast in" at correct position during construction of wall
Pipe and duct penetrations through the building envelope	Carry out final weatherproof flashing over pipe or duct angle flange	Provide or cut hole. On ducts through roofs provide and fix timber or metal up-stands.
Fire dampers	Supply fire damper frame and hand to others for fixing. Supply and install fire damper.	Prepare holes or form/cast hole, provi lintel and fix fire damper frame supplie by others. "Make good" around dampe frame to provide correct fire barrier.

Duct and louvre connections to walls	Supply and install all louvres	Form hole and install timber or angle iron frame and "make good".
External louvres	Supply and hand over to others for installing all louvres. Fixing details shall be agreed between all parties prior to louvres being ordered.	Install all louvres supplied by others including weatherproofing and providing mastic seals where required.
Concrete bases and plinths	Provide all necessary dimensions and details for work by others. Supply and install holding down bolts. Where equipment fixings are drilled into bases, undertake drilling and "making good" after installation.	Prepare bases to required tolerances for equipment with pockets for holding down bolts. "Make good" around holding down bolts after installation by others.
Inertia pads and inertia block bases	Provide all necessary dimensions and details for work by others. Where neoprene inertia materials are to be provided in concrete bases supply and hand over materials to others for correct fixing and final construction of base. On inertia block bases hand over framework (including holding down bolts and AV mounts) for others to fix and fill the inertia block with concrete and "make good".	Install inertia materials supplied by others in the final construction of the base. For inertia block bases receive the framework from others (including holding down bolts and AV mounts) Fix and fill the inertia block with concrete and "make good".
Steelwork bases	Provide all necessary dimensions and details for work by others. Supply and hand over steelwork bases, plinths, channel support steels for fixing and weatherproofing by others.	Fix and weatherproof.
Secondary steelwork for support	Provide all necessary dimensions and details for work by others. Provide suitable steelwork for permanent fixing by others onto the main building steelwork frame or concrete frame where large spans of steelwork are required for support. On short lengths of secondary steelwork under 2m long undertake permanent fixing onto the structure, provided that drilled fixings are allowed. If "casting in" fixings are required preparing the hole	Undertake permanent fixing of steelwork supplied by others. If "casting in" fixings are required prepare the hole and "make good" around fixing supplied by others.

	and "making good" around fixing shall be by others.	
Anchor points and guides	Provide all necessary dimensions and details for work by others. Hand over to others for fixing permanently to the building structure unless steelwork supplied is used for the anchor point or guide fixing.	
Drainage under this contract within building	Terminate all drainage works at appropriate connections within the lowest slab level for final connection by others.	
Underground drainage and external drainage	By others	
Underground drainage and external drainage	Undertaken as part of contract Works	
Final connections to manholes	By others	
Final connections to manholes	Undertaken as part of contract Works	
Trenches and back-filling for drainage and/or distribution services	By others	Undertake formation of trenches and associated back-filling to the approval of the installer of the associated services
Acoustic enclosures	Supply, fix, weatherproof and "make good" acoustic seal around enclosure providing tolerances are within the normal building allowances.	
Anti-vibration mountings	Install Anti-vibration mountings Undertake direct drilling fixings if applicable.	Make final fixing to building structure and "make good" any holding down pockets.
Sound attenuators	Supply and install in formed plantroom(s) wall or floor openings.	"Make good" around attenuator with acoustic non-setting mastic.
Fire extinguishers	Provide and fix all fire extinguishers	
Fire extinguishers	Supply fire extinguishers for fixing by others	Receive fire extinguishers from others and fix
Conduits and electrical cabling chased into building fabric	Install and test conduits/cabling and protective coating.	Prepare wall chase (s) and make good around conduit or cabling after installation and testing of cabling and protective coating by others.
Manhole covers and frames	Supply and handover to others for fixing	Undertake fixing and "making good"
Pipework and cabling entrances to and exits from buildings below ground	Supply and handover pipe ducts for installation by others	Install pipe ducts under and into building for services installed by others. Make waterproof seal around installed services.

1015000 DRAWING DEFINITIONS

1015001 General

This section outlines definitions used to clarify the extent of information appropriate to different drawing types.

1015002 Tender drawings

The tender drawings primarily describe the design intent of the Works, the working principles of the systems, general arrangements, principles of services co-ordination and the intended methods of installation.

The drawings are accordingly part diagrammatic with runs of piping, ducts, cable, conduit and the like being shown to small scale and not necessarily indicating exact installation positions.

The drawings shall also provide sufficient information:

- To facilitate the preparation of an estimate and tender
- To enable all other participants to appreciate the inter-relation of the works with other trades and disciplines
- When read in conjunction with the architectural and structural engineering drawings to enable the preparation of the final or supplementary builder's work information, co-ordination, installation and shop drawings incorporating manufacturing drawings and final details of specified or selected plant and equipment.

The drawings indicate equipment, pipework, ductwork, cable tray routes and trunking, in sufficient detail to show how all the engineering services can generally be accommodated and coordinated with each other, the architecture and the structure. These drawings are provided for information purposes only. The installer shall be responsible for all detailed co-ordination of building services.

Any dimensions are stated for elements that have a visual impact on the completed Works.

The drawings will not necessarily show dimensions required to construct the works nor will they accurately locate every item of equipment or plant ancillary which does not influence the visual impact of the completed works. The decision of the CA as to what has a visual impact shall be final.

Confirm mounting heights with the CA before commencing the work on site.

Co-ordination drawings do not detail the building fabric or structure whether new or existing nor are they based on survey drawings or installation drawings of any other party or consultant.

Obtain all information required to produce the co-ordination and installation drawings or requirements at no cost.

Where it is necessary to survey an existing building or existing structure or services within that building to prepare coordinated installation and shop drawings undertake responsibility for obtaining that information. The cost of obtaining that information must be included in the contract price.

In the case of new services installations within a 'shell and core' type development allow for all costs associated with obtaining all necessary details of the base services systems from the relevant contractor's and/or design team for incorporation into the shop and installation drawings.

Plant and equipment is shown based upon the manufacturers' catalogue information and is subject to verification or revision when manufacturers' drawings are available.

Interpret the design intent of the tender drawings and reflect same in the co-ordination and installation drawings subject to the comments of the CA. Where differences occur between the tender and the co-ordination and installation drawings these differences shall be deemed to be included in the contract price for the Works and no additional cost shall be allowed due to any variation in layout, arrangement or detail unless the deviation is specifically covered by an CA Instruction before the production of the drawings.

Where sprinkler installations are provided, the information shown on the tender drawings will indicate the design intent but this must be subject to verification by the approved installer who shall accept full responsibility for the design in accordance with the LPC Rules.

Where medical gas and BMS installations are provided the information shown on the drawings is subject to verification by the approved installer who shall accept full responsibility for the design

1015003 Sketch drawings

Line diagrams and layouts indicating basic proposals, location of main items of plant, routes of main pipes, air ducts and cable runs in such detail as to illustrate the incorporation of the engineering services within the project as a whole.

1015004 Concept schematic drawing

Line diagrams indicating main items of plant and their interrelationships in such detail as to illustrate the incorporation of the engineering services within the project as a whole

1015005 Detailed schematic drawing

A line diagram describing the interconnection of components in a system showing the engineering principles. The main features of a schematic drawing are:

- A two-dimensional layout drawing with divisions to show the distribution of the system between building levels. Or an isometric style layout indicating the distribution of systems across individual floor levels. The drawing is not necessarily constructed to scale.
- Includes all functional components that make the system work eg plant items, pumps, fans, dampers, valves, strainers, terminals, electrical switchgear, distribution and components.
- Symbols and line conventions in accordance with industry recognised standards for symbols and other graphic conventions.
- Labeled with appropriate pipe, duct and cable sizes.
- Indicate components that have a sensing and control function including their interrelationship, eg. building management systems, fire alarms etc.
- Components indicated on the schematic drawing identified for cross-referencing purposes.
- Include all data essential to testing and commissioning including volumetric flow rates, design total pressure losses at equipment, locations of dampers, valves and flow measuring stations, electrical fault levels, current ratings, short circuit capacities and tripping times, etc.

1015006 Technical design drawing

A drawing showing the extent of the services installations. The main features of technical design drawings are:

- Plan layouts to a scale of at least 1:100.
- The drawings shall show the extent and type of services terminals visible within the space
- Approximate locations of horizontal and vertical service runs shall be shown

- Plant and distribution system sizes, particularly those affecting spatial allocation, while acknowledging that these may need some adjustment and refinement in the preparation of the detailed design drawings and equipment schedules
- Pipework and electrical containment should be represented by single line layouts. Ductwork should be represented by either double or single line layouts as required to demonstrate that the routes indicated are feasible.
- Symbols and line conventions in accordance with industry recognised standards for symbols and other graphic conventions.

1015007 Detailed design drawing

A drawing showing the intended locations of plant items and service routes in such detail as to indicate the design. The main features of detailed design drawings are:

- Plan layouts to a scale of at least 1:100.
- Plant areas to a scale of at least 1:50 and accompanied by cross-sections.
- The drawing will not indicate the precise position of services, but it should be feasible to install the services within the general routes indicated. It should be possible to produce co-ordinated working drawings or installation drawings without major re- routing of the services.
- Pipework and cable containment represented by single line layouts.
- Ductwork represented by either double or single line layouts as required demonstrating the routes indicated are feasible.
- Symbols and line conventions in accordance with industry recognised standards for symbols and other graphic conventions.
- The drawing should indicate the space available for major service routing in both horizontal and vertical planes

1015008 Co-ordinated working drawing

A drawing showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of co-ordinated working drawings are:

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 for all congested areas.
- The drawing should make allowances for installation working space and spave to facilitate commissioning and maintenance.
- The drawing should be spatially co-ordinated i.e. there should be no physical clashes between the system components when installed.
- Critical dimensions, datum levels and invert levels should be provided together with dimensions in areas where tolerances are minimal.
- Spaces shown on the drawing should make allowance for the service at its widest point eg spaces between pipe and duct runs. Allowances for insulation, standard fitting dimensions and joint widths should be included on the drawing
- Make allowance for those plant items specified by the designer and identified in the design specification.
- The drawing should indicate positions of main fixing points and supports where they have significance to the structural design.
- The drawing should demonstrate a feasible sequence of installation of the services.
- The drawing should be supported with individual services drawings for clarity.
- Plant room layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20.

1015009 Installation drawing

A drawing based on the detailed design drawing or co- ordinated working drawing with the primary purpose of defining that information needed by the tradesmen on site to install the works. The main features of installation drawings are:

- Plan layouts to a scale of at least 1:50, accompanied by cross-sections to a scale of at least 1:20 for all congested areas.

- A spatially co-ordinated drawing, ie no physical clashes between the system components when installed at the scaled-off positions shown on the drawing.
- Make allowance for inclusion of all supports and fixings necessary to install the works.
- Make allowance for the service at its widest point for spaces between pipe and duct runs.
- Allow for insulation, standard fitting dimensions and joint widths on the drawing.
- Make allowance for installation details provided from shop drawings.
- Make allowance for installation working space; space to facilitate commissioning and space to allow on-going operation and maintenance in accordance with the relevant health and safety requirements.
- Make allowance for plant and equipment including those that are chosen as alternatives to the designer's specified option.
- Provide dimensions where the positioning of services is considered to be important enough not to leave to the tradesmen on site
- Plant room layouts to a scale of at least 1:20, accompanied by cross-sections and elevations to a scale of at least 1:20.

1015010 Installation wiring diagram

Drawing showing the interconnection of electric components, panels etc in accordance with the design and incorporating the details provided on manufacturer's drawings.

The information shall indicate maximum electrical loading for each supply cable; cable termination facilities; and cable identification and all terminal numbers.

1015011 Manufacturer's drawing

Drawing provided by a manufacturer, fabricator or supplier for a particular project, and which is unique to that project and indicates a project specific representation of the product, components or plant items to be supplied. Examples include ductwork, pre-fabricated pipework, sprinkler systems, control and switchgear panels and associated internal wiring, pre-fabricated plant customized plant and equipment etc.

1015012 Manufacturer's certified drawing

Drawing provided by a manufacturer or supplier to indicate details of the product, components or plant items and which the manufacturer or supplier guarantees the supplied equipment will comply with

1015013 Record drawing

Drawing showing the building and services installations as installed at the date of practical completion. The main features of the record drawings are:

- Provide a record of the locations of all the systems and components installed including pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.
- Use a scale not less than that of the installation drawings.
- Have marked on the drawings the positions of access points for operating and maintenance purposes.
- The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.
- The location, including level if buried of public service connections provided within the contract, no matter who installed them, together with the points of origin and termination, size and materials of pipes, line pressure, flow and other relevant information.
- Location and depth of all buried services
- Schematic drawings of each system indicating principal items of equipment, zoning, means of isolation, etc in sufficient detail to understand the system operation and the inter-connections between various systems

- The layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes, drain cocks, test points, gauges, flow or pressure switches and other instruments.
- Location, identify, size and details of all equipment and controls equipment served by, or associated with, each of the various services.
- The layout, location and extent of all air ducts, including those formed in builder's work or otherwise outside the contract, showing dampers and other equipment, acoustic silencers, grilles, diffusers, other air terminals, balancing dampers, access panels, fire dampers, turning vanes, hand holes, test holes, gauges and instruments. Each duct and terminal shall be marked with its size and air quantity flowing. Each terminal unit or grille shall have its duty clearly shown as recorded from the commissioning results.
- The location and identity of each room including space housing plant, machinery or apparatus.
- Detailed general arrangements of all boiler houses, machinery spaces, air handling plant rooms, tank rooms, electrical switch-room and other plant or apparatus, including the location, identity, manufacturer, size and rating of each item.
- All necessary sections, elevations, isometrics and schematics of the plant spaces.
- Control and wiring diagrams shall be provided incorporating details of each instrument and equipment item and written description of the sequence of operation of each system. All diagrams shall include full details of internal panel wiring and connections to field mounted items.
- Layout, location and extent of electrical switchgear, distribution boards cables and termination points.
- Detailed general arrangements of all switch-rooms, riser cupboards, service trenches, transformer chambers, generator rooms and other plant or apparatus, including the location, identity, manufacturer, size and rating of each apparatus
- Details to show inter-connections between the works and equipment or systems provided by others to which wiring and connections are carried out as part of the works
- Detailed wiring drawings and diagrams for all systems showing origin, route, cable containment size, type and number of conductors, length termination size and identification, and measured conductor and earth continuity resistance of each circuit. Indicate if cable/conduit is surface mounted, concealed in wall chase, in floor screed, cast in-situ, in false floor, above ceiling void, etc.
- Logic flow diagrams for each individual control or monitoring specification and for each engineering system to illustrate the logical basis of the software design

1015014 Builder's work drawing and information

Drawings and/or schedules, appropriate to the stage of design development showing the requirements for architectural and/or structural provisions necessary to facilitate the engineering services and allow their integration into the project. Such information includes the position and sizes of all access covers, panels and doors required in the building structure and fabric for proper safe access for and to plant for installation, maintenance, inspection and future replacement.

Design stage
A drawing and/or schedule to show the provisions required to accommodate the engineering services that significantly affect the design of the building structure, fabric and external works. The information also indicates the work to be carried out by building trades eg. plant bases, major openings and major structures for plant and equipment.

This will be appropriate to the stage of design development and maybe based on preliminary, non-manufacturer specific plant selection.

Installation stage
Drawings to show requirements for building works necessary to facilitate the installation of the engineering services and as described elsewhere.

1015015 Controls logic diagrams

Diagrams, drawings and/or schematic details of all control components and instruments showing the layout with each item uniquely identified together with a description of the controls operation and details of the associated interlocking.

Switchgear, starter and control instrumentation panel drawings

Drawings that show the construction and internal wiring diagrams of the starters, panels and/or other devices.

1016000 RECORD DOCUMENTATION

1016001 General

Be advised that great importance will be placed upon quality, accuracy, clarity and completeness of the record documents and upon these being made available promptly.

Practical completion will not be granted unless an approved copy of the record documentation has been prepared, and is available for handover to the Employer.

Comply with the requirements of the CDM Regulations in providing the appropriate input to the health and safety file for the Works.

Comply with the requirements of the Building Regulations in providing all necessary documentation and information.

Provide record documentation, as detailed elsewhere, to include but not limited to:

- Record drawings and schedules
- Plant room and switch room drawings, schedules and schematics
- Operating and maintenance manuals
- Blank maintenance logs
- Building log book information

Ensure record documents clearly record the arrangements of the various sections of the works as actually installed and identify and locate all component parts.

The record documents shall set out the extent to which maintenance and servicing is required and how, in detail, it should be executed. Sufficient, readily accessible and proper information shall be provided to enable spares and replacements to be ordered.

Correlate record documents so that the terminology and the references used are consistent with those used in the physical identification of the component parts of the installations.

Demonstrate as required throughout the execution of the contract works that complete and accurate records are being maintained and that the record documents are being progressively compiled as the work on site proceeds.

The Employer shall have sole copyright to all documents produced specifically for the manual. The Employer shall be entitled to produce copies of all parts of the manual for his own use. If the Employer transfers ownership or responsibility of the installations he shall be entitled to transfer his copyright of documents included in the manual.

1016002 Record drawings

Record drawings of the complete Works shall be provided at practical completion.

Record drawings of the final "as installed" layouts shall be issued in draft form to the CA for examination 4 weeks prior to the testing and commissioning period to allow checking for accuracy.

Record drawings will be prepared in CAD format as agreed with the CA prior to production of the drawings.

All drawings shall be suitably layered, with different services on each layer. A detailed list of layers, external references or equivalent (if used) and list of files shall be provided with the discs. If the drawings were produced from CAD drawings provided by the CA, the same layering system shall be used.

The drawings shall be produced in full size metric units.

Once approved the complete set of record drawings shall be revised as necessary to incorporate testing and commissioning data where applicable, and the final set(s) of record drawings and computer discs shall be handed over at practical completion.

Issue at practical completion the complete approved package of record drawings in the following numbers:

CAD disk(s) 2 no sets of complete record drawings
'white' prints 2 no sets of complete record drawings

Each CD shall be labelled and CD jewel cases shall be labelled identifying project title, issue date and index of contents.

Valve charts, electrical distribution charts in panels and the like, shall be issued for examination at agreed dates to allow adequate time for manufacture and installation prior to practical completion.

Where portions of the work are to be concealed, draft copies of record drawings shall be supplied to the CA before the work is concealed in order to facilitate checking and examination.

The record documents shall be correlated so that the terminology and the numerical and/or other references used therein are consistent with and similar to those used in the physical identification of component parts of the Works.

Each record drawing shall show the following information:

- The name of the contract and, where appropriate, the zone or floor designation.
- Description of drawing, drawing reference and scale.
- Name and address of the contractor and the consulting engineer.

The completed drawings shall be signed as record drawings.

Each record drawing shall be endorsed with the words 'Record Drawing' in the bottom right hand corner adjacent to the title block.

Mark up 'as installed' details weekly and before any work is hidden from view.

Failure to undertake the above procedure for the preparation of record drawings and leaving the production of such drawings too late in the construction/commissioning period will result in practical completion not being granted by the CA.

1016003 Plant room and switch room drawings, schedules and schematics

Provide good quality plant and switch room drawings, schedules, schematics and instructions and hang in the respective plant room or any other appropriate location or where directed by the CA.

Protect surfaces of such information by pressure lamination and hang using suitable fixings and provide backboards if necessary.

A sample shall be submitted for approval prior to commencing production.

Provide information as stated elsewhere and include:

- All information required under statutory or other regulations
- Location of all incoming service isolating and metering facilities
- Emergency operating procedures including details for emergency call out service
- First aid instructions for treatment of persons after electrical shock
- Schematic drawings of installations showing
  a. location, identification and duties of equipment.
  b. location of controls devices.

c. circuit layout.
- Controls schematics
- Valve schedules showing reference, type, location, application/service and normal operating position

Prior to being fixed, plant and switch room drawings, schedules, schematics and instructions shall be submitted for review by the CA. The review procedure shall be as for record drawings as stated elsewhere and all items shall be fixed prior to practical completion.

1016004 Operating and maintenance manual specialist

Employ a specialist to prepare the operating and maintenance manuals in accordance with the requirements of this specification.

Submit details of the proposed specialist to the CA for approval prior to commencement of the Works.

1016005 Operating and maintenance manual requirements

Agree format and contents of the operating and maintenance manuals with the CA prior to commencement of the Works.

Provide the operating and maintenance manuals in the following form:

- Paper format - encase the manuals in A4 size, plastic-covered, loose leaf, four ring binders with hard covers
- Electronic format stored on CD

Provide copies of the operating and maintenance manual as follows:

- Provide 2 draft paper format copies for comment
- Provide 2 final paper format for Client use
- Provide 2 final electronic format copies stored on CD for Client use

Submit a draft copy of the operating and maintenance manual to the CA for comment 4-weeks before the contract completion date and prior to the testing and commissioning.

The draft copy of the manual shall conform to the required format and contain all the information identified in this specification with the exception of any information not available at that time (such as commissioning results). The draft copy of the manual shall be contained in temporary loose leaf binder(s) and clearly display the word “DRAFT”.

Once approved a draft copy shall be handed over prior to instructing the employer's staff in the operation and use of the services installations. This copy shall contain all testing and commissioning data and test results, actual control set points and the like in draft form.

Prior to practical completion provide copies of the final manual which shall include all testing and commissioning results and final plant duties and control settings, etc. in a typed form.

All CD’s and other electronic forms of delivery media associated with the manual shall be clearly labelled with:

- A heading stating “O&M manual” and disc number if more than one disc
- Details of the premises and systems covered
- The issue number of the manual and date of release

Retain a copy of all the delivered record documentation for at least one year after practical completion. If requested by the Employer or CA during this period, provide additional copies subject to a charge.

Undertake the following activities:

- Liaise with the CDM co-ordinator and any other parties associated with the production of the Health and Safety File to ensure that the required information is complete and that the method of presentation and terms used are consistent.
- Liaise with members of the design team to obtain all information necessary to convey a thorough understanding of the design intent and operating principles of the installations.
- Liaise with designated contractors and specialist subcontractors to obtain all necessary details of the installed systems and equipment to enable safe and proper operation and maintenance.
- Liaise with specialist equipment suppliers as necessary to ensure that clear operating and maintenance instructions are included in the manual.
- Prepare additional written, diagrammatic and/ or pictorial information as necessary for the operation and maintenance of the engineering services installations
- Re-draft and restructure information provided by others as necessary so as to ensure consistency with other parts of the manual and other sections of the Health and Safety File.
- Submit periodic reports to the CA on the progress of the preparation of the operation and maintenance manuals.
- Collate all the information into a co-ordinated, indexed and cross-referenced document
- Provide all necessary materials required for the production of the draft and final editions of the operation and maintenance manuals.

Be responsible for the correction of any errors or omissions in the manual.

All aspects of the manual shall comply with relevant requirements of the CDM Regulations for the provision of information for the Health and Safety File.

Where appropriate, the maintenance procedures and frequencies detailed in the manual shall be in accordance with details provided by the manufacturer for specific items of equipment. Where specific requirements are not pertinent, the procedures and frequencies shall be as recommended by HVCA or BSRIA.

Care shall be exercised to ensure that maintenance procedures and frequencies described in manufacturers' printed details are accurately reflected in the text of the manual and appropriate for the application.

Identify from the CA the intended maintenance strategy for the works and the level of technical competence and user ability of the personnel likely to be employed. The manual shall be written in a style to suit the abilities of all users. Where necessary, prepare separate sections to suit the following levels of competence:

- non-technical – eg building manager or caretaker requiring simple directions for basic operations.
- general technical – with broad-based maintenance skills required for routine maintenance, inspections etc and detailed analysis of system operation.
- specialist – in individual fields and with respect to particular items of equipment.

1016006 Operating and maintenance manual layout

The manual shall conform to the following minimum standards:

- All documentation shall be in English as spoken and written in the United Kingdom.
- All units of measurement shall be metric, conforming to the SI system.
- The text of descriptive sections shall be concise and complete avoiding possible ambiguity or misunderstanding. All information shall be pertinent to the specific installations. Irrelevant material or material of a general nature shall not be acceptable. Where generic standard clauses are used as the basis for certain parts of the manual, they shall be edited to ensure that all text is relevant to the Works.

- Jargon shall be avoided. All new terms shall be defined when first introduced. Abbreviations shall only be used if they have been defined or their meaning is clear from the text.
- The imperative mode shall be used for instructions regarding operation, maintenance, disassembly etc.
- Illustrations, drawings and diagrams incorporated into the manual shall be easily read in conjunction with the relevant text
- The covers shall be substantial, of adequate size, distinctive and of sufficient strength to protect the contents for the life of the installation. The method of binding shall give a permanent anchorage along the left-hand side whilst allowing the text to be flat without damage to the spine.
- The manuals shall be prepared using an approved typeface using good quality A4 paper suitable for direct insertion into the manuals
- The front cover and where appropriate the spine, shall have the information clearly displayed in permanent lettering
- The manual shall have an alphabetical index or indexes. The indexing and cross-referencing in other parts of the manual shall be arranged to provide easy access to required information.
- Dividers between sections shall be stepped, overlapping printed card. The divider shall be labeled to identify the section of the manual that it proceeds.
- All pages comprising the manual shall be subsequently numbered according to each section (i.e. section 1 pages numbered 1/1, 1/2,etc., section pages numbered 2 2/1, 2/2etc.)
- Fold drawings larger than A4 and include in the binder so that they may be unfolded without being detached from the rings.

1016007 Operating and maintenance manual content

The manual shall be arranged as follows unless an alternative format and contents are agreed with the CA prior to issue of the draft document:

Front cover and fly sheet

General details to be shown on all volumes shall include:
- Document title - Operating and Maintenance Manual
- Employer name and logo
- Premises name
- Services referred to in the manual
- Volume reference where the manual runs to more than one volume
- Description of contents (eg General Information and Design Details)

Spine details

Spine details shall be shown on all volumes and include:
- Services referred to in the manual
- Volume reference where the manual runs to more than one volume
- Description of contents (eg General Information and Design Details)

Title pages

- Premises name and address (authenticated postal address, phone, fax, e-mail etc)
- Services referred to in the manual
- Full name and address of the Employer
- Date of completion and date of handover of the services to the Employer
- Date of issue
- The author's reference number of the manual
- Name and address of the author of the manual

Contents and index

- The contents list for the whole manual shall comprise a master list of main headings of each section for each volume of the manual, for cross reference. Copies of this master contents list shall be included in the master contents list for the Health and Safety File.
- Detailed contents for the particular volume shall include a structured contents list showing main headings and details of contents of each section in that volume, with paragraph numbers and page numbers.
- Detailed contents for each section are to be located at the front of each section of the manual, giving a detailed, structured list of the contents of the respective section.
- Index comprising a comprehensive alphabetical index for all sections of the manual

Section 1 General information and introductory overview

The information contained in this section shall include:

- Full name, address, telephone and facsimile numbers, website address and email address of the design team and all installing contractors, sub-contractors and specialists for the works
- Full name, address, telephone and facsimile numbers, website address and email address of all public utilities and local authorities
- Any limitations on the use of the manual
- Record of amendments to manual schedule (including space for future records)
- Description of how to use the manual
- List of all supplementary documents
- Distribution list and locations of all copies of the manual
- Scope including a brief description of which systems and details are included in the manual

Section 2 Contractual and legal information

The information contained in this section shall include:

- Details of ownership, leases etc defining areas of responsibility for operation and maintenance
- Construction / handover dates including installation start date(s), practical completion date and end of defects liability date
- Details and copies of all manufacturers' guarantees or warranties together with maintenance agreements offered by sub-contractors or manufacturers. Include expiry dates.
- Insurance inspection reports. Documents pertinent to Employer's / User's liability
- Local and public authority consents. To include permissions required for access, alterations etc
- Safety and fire certificates. Certificates confirming that the premises and installed systems may be safely utilised. These shall include examination certificates by competent persons for pressure systems etc, together with written schemes of examination for pressure systems.
- Software licence information.
- Copies of Energy Performance Certificates

Section 3 Health and safety

- Features or characteristics that may produce a hazard. Flammable, toxic or otherwise deleterious substances necessary for the operation of systems; restricted access; pressure systems etc
- Known hazards against which protection can be provided
- Mandatory requirements relating to safety. To include details of all systems and equipment requiring periodic inspection/ examination/ testing to comply with relevant regulations, approved codes of practice etc
- Relevant safety precautions. To include procedures to minimise the risk of damage or injury from recognised hazards. Requirements for special manual procedures, permits to work etc.
- Details of recommended first aid equipment to be maintained on the premises.

Section 4 Emergency information

Contact information for:

- Utility supplier emergency services (gas, water, electricity)
- Provider of emergency call out service
- Installer's emergency staff
- Security/fire systems
- Location of first aid equipment
- Emergency control locations
- Water main stopcock(s)
- Gas shut –offs
- Electricity isolation points
- Specific systems/plant

Section 5 Description of services and design intent

- A schedule of the floor areas of each of the building zones categorised by environmental servicing type
- Description of the whole building and intended use
- Design philosophy including all design criteria
- A full description of each of the installed systems and items of equipment. To include as a minimum a written explanation of the following:
  a. Scope
  b. Intended purpose
  c. Plant and distribution locations; divisions of main zones; etc, cross-referenced to schematics
  d. Function
  e. General design parameters
  f. Installed capacities
  g. System capacities (based on commissioning results)
  h. Restrictions of the systems
  i. Planned operational efficiency and most economic mode of operation
  j. Expected service life
  k. Manufacturers information concerning correct operation

Section 6 Equipment schedules

System by system schedules of all plant, equipment, valves, distribution boards etc stating as minimum:

a. Component type
b. Unique asset number
c. System
d. Location
e. Number off
f. Duty and size
g. Performance figures
h. Manufacturer and supplier
i. Manufacturer's model and/or reference number
j. Manufacturer's serial number and nameplate details
k. Original order number for the particular plant/equipment item

Each item of plant/equipment must have a unique asset number cross-referenced to the record drawings and schedules.

Section 7 Systems operation

Descriptions of the operational and control strategies to include:

- Control and operating strategy for each system
- Outline of general operating mode including summer and winter operation
- Start-up and shut down procedures. Description of procedures for whole system and individual items of plant, from fully off to fully operational, including interlocks etc.
- Interlocks and inter-dependencies between plant and systems.

- Procedures for emergency shut down and operating procedures for standby plant.
- Means of making safe potentially dangerous plant
- Precautions necessary to overcome known hazards when operating each system, bringing into operation all standby equipment included in each system
- Instructions on fault finding and emergency in case of plant malfunction or equipment failure control sequences for all systems installed
- Details of all software provided and procedures for updating and/or modifying software operating systems and control programs
- Instructions for the creation of control procedure routines and graphic diagrams where applicable

Section 8 Energy management

- Energy management strategy to enable energy consumption to be monitored and controlled.
- Metering philosophy. To include a schedule of the building's energy supply meters and sub-meters. Indicate for each meter, the fuel type, its location, identification and description, and instructions on their use.
- Carbon emissions and the comparable performance benchmarks / target figures for energy consumption and energy costs. *(Design assessments to be in accordance with Building Regulations)*
- The measured air permeability of the building
- Forms for recording plant running hours, energy consumption and energy costs.

Section 9 Maintenance

Maintenance instructions for each item of plant, co-ordinated from manufacturer's details and recognized industry guidelines including:

- frequency and recommended routine maintenance activities
- guidance on the nature of deterioration and defects to look for
- dismantling and re-assembly instructions
- adjustment , calibration and testing instructions
- special tools needed for maintenance *(cross referenced to the particular item)*
- test equipment and auxiliary services
- reference to spare parts and replacements
- Programme and frequencies for planned preventive maintenance.
- Comprehensive schedules identifying:
  a. routine periodic checks on plant / system status and condition.
  b. periodic verification of accuracy of controls, instruments etc.
  c. routine visual and physical checks, measurements and certification of continuing fitness for purpose and safety.
  d. routine checks / changes to plant / system components / settings to compensate for wear, operational requirements, experience in use etc so as to ensure continuing optimum performance.

Recommended frequencies and procedures for routine lubrication of moving parts, including generic specification for lubricants.

Procedures for fault finding and identifying causes of abnormal operation of plant / equipment.

Section 10 Spares and tools

- Schedule of types of replaceable assemblies, components etc particular to specific plant.
- Schedule of specialist tools / equipment particular for specific plant and necessary for undertaking work at height etc.
- Separate parts lists shall be provided for each item detailed in the equipment schedule.
- Schedule of normal consumable items
- Recommended stocking levels

- Schedule of personal protective equipment necessary for operation / maintenance activities / tasks

Section 11 Drawings

- A schedule of all engineering services record drawings for the Works. The information to include drawing title, number, source, revision, date, system detail, file/storage location. The schedule to include space to record future modifications and dates.
- An A3 size reduced copy of all record drawings together with an index.
- An A3 size reduced copy of all plantroom and switchroom drawings, schematics and schedules
- Legend for all colour-coded services
- Schematic drawings of each system, indicating principal items of plant, equipment, valves, etc.
- A schedule of all manufacturers' drawings for the Works. The information to include drawing title, number, source, revision, date, system detail, file/storage location. Schedule to include space to record future modifications and dates.

Section 12 Testing and commissioning data

- Copy of report(s) confirming that the Works were satisfactorily commissioned signed by a competent person(s)
- Copies of all test certificates, records, commissioning and performance test records for the Works. All certification shall be signed and witnessed.
- Method statements for the testing and commissioning procedures undertaken including description of equipment used.
- Copies of calibration certificates for all test equipment.
- Schedules of all fixed and variable equipment settings established during commissioning.

Section 13 Manufacturers' data

- Schedule of all manufacturers and suppliers indicating company name, address, telephone and facsimile numbers, email address(es), website address and equipment unique asset number. (Sorted in company order alphabetically)
- Product (manufacturer's) data/ literature for all items of equipment and plant installed. The information to be project specific and include detail drawings, electric circuit details and operating and maintenance instructions.

Section 14 Materials and substances

- Register of harmful substances. Details of any materials that could be hazardous to health, used in connection with or otherwise relevant to operational or maintenance activities.
- COSHH details
- Register of recyclable materials
- Methods for safe disposal or destruction of any parts, materials or components.

Provide a data sheet for each material known to constitute a potential hazard, with detailed procedures for its safe, authorized disposal.

Section 15 Modification information

- Provide details of allowances made by plant manufacturer or system designer for modifications
- Provide space in manual to record future modifications.

1016008 Building log book

The contractor shall be shall be responsible for compiling the building log book where necessary.

Prepare and submit to the party responsible for compiling the building log book all necessary information for inclusion in the document to meet the requirements of the Building Regulations and in accordance with CIBSE TM31 Building Log Books – A guide and templates for preparing building log books.

Clearly, there are direct links between the building log book and the operating and maintenance manual, record drawings etc. The building log book information is an additional requirement to the responsibilities for the production of record documentation as stated elsewhere.

Practical Completion will not be granted if the required information is not issued.

1018000 COMPLETION AND HANDOVER

1018001 Handover requirements

As a pre-requisite to Practical Completion in respect of the contract works or part thereof, demonstrate to the satisfaction of the CA that:

- All the contract works are complete. With the exception of minor snags or limited defects as agreed with the CA that could be reasonably completed within an agreed programme without causing disruption to the Employer's use of the building or part thereof.
- All spares, keys, tools and other consumables as stated elsewhere have been supplied and handed over to the Employer.
- The instruction of the Employer's staff in the use and correct operation of the installation has been completed satisfactorily. In particular, safety devices and controls demonstration.
- All commissioning and testing completed including the issue of a final commissioning reports signed by an approved competent person
- A complete demonstration of the contract works including fully functional operational controls tests undertaken in the presence and to the satisfaction of the CA.
- All necessary certification by the Employer's insurers has been completed.
- All approved record documentation including record drawings, operation and maintenance manuals, etc is approved and issued
- All information required for the health and safety file is issued to the satisfaction of the Planning Supervisor.
- All necessary Statutory Authority approvals have been undertaken and written confirmation established
- Completion and issue of building log book information in accordance with Building Regulations.

Should adequate record documentation not be available Practical Completion will not be granted.

1018002 Reading of meters

On completion of the Works record readings of all water, gas and electricity meters and forward to the CA.

1018003 Recommended spares

Before practical completion submit to the CA a schedule of spare parts as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the Works.

Submit the schedule of spare parts six weeks before practical completion

The schedule shall be priced in detail and include the following information for each item:

- Manufacturer's current price (including packaging and delivery to site)
- Quantity to be provided
- Manufacturer's reference for the item
- Referencing to the plant and equipment installed
- Purpose

Identify the items that are additional to those specified and included in the contract price.

Submit to the CA a quotation, priced in detail, for the additional items.

1018004 Supply of spare parts

Two weeks prior to practical completion provide all specified spare parts and the additional items if so instructed by the CA.

For each spare part provided include for and undertake to:

- Check that each spare part is suitable for the replacement of the corresponding part supplied with the plant and equipment installed
- Reference to the plant and equipment information in the operating and maintenance manual so purpose is clear
- Label and reference in accordance with the schedule of spare parts
- Paint, grease and pack as necessary to prevent deterioration during storage

All spares shall be contained where practicable in protective containers.

1018005 Recommended tools

Prior to practical completion submit to the CA a schedule of tools and portable instruments as stated elsewhere and recommend any that should be obtained and kept in stock by the Employer for maintenance of the installations included in the Works.

Submit the schedule of tools and portable instruments six weeks before practical completion

The schedule shall be priced in detail and include the following information for each item:

- Manufacturer's current price (including packaging and delivery to site)
- Quantity to be provided
- Manufacturer's reference for the item
- Referencing to the plant and equipment installed
- Purpose

Identify the items that are additional to those specified and included in the contract price. Submit to the CA a quotation, priced in detail, for the additional items.

1018006 Supply of tools

Two weeks prior to practical completion provide all specified tools, keys and portable instruments and the additional items if so instructed by the CA.

Include for and undertake to:

- Check that each item is suitable for the intended application
- Label and reference each item identifying purpose and the plant or equipment
- Paint, grease and pack as necessary to prevent deterioration during storage

All tools, keys and portable instruments shall be secured and contained in lockable cabinets that will be located as agreed with the CA.

1018007 Inspection by employer's insurers

Where indicated elsewhere installations, equipment, plant or materials are to be inspected by a representative acting for the Employer's insurers. The installations, equipment, plant or materials shall satisfy the insurance company's requirements in all respects.

Provide a programme for the inspection and certification and inform the CA when the installation or equipment is ready for examination.

Ensure all necessary information is provided to enable the insurers to approve the design before manufacture.

Arrange for the attendance of the insurance company's representative at agreed stages of manufacturer and installation and provide all necessary attendance, access and facilities for inspecting and testing as is required.

No equipment or installations subject to inspection and certification will be accepted on behalf of the Employer unless a satisfactory certificate has been received from the insurers.

The Employer will place an order with the insurance company and all insurance company charges will be included in the contract price

All other costs associated with such inspections shall be included in the contract price.

1018008 Instruction of employer's staff

At a time to be agreed with the CA and prior to practical completion instruct the Employer's staff in the use, correct operation and general maintenance of the Works and be satisfied that such staff is competent to take over the installation on completion. Include adequate periods to instruct the Employer's staff in the operating and maintenance of the Works.

Submit to the CA for approval a detailed training programme and method statement for the training of the Employer's staff 4-weeks before commencement of training.

During such periods of instruction undertake and be responsible for the correct operation and maintenance of the installations.

Employ the services of relevant specialists and suppliers necessary for this purpose and provide each person with a comprehensive set of teaching notes and diagrams.

All the associated training equipment required by the trainer(s) to enable the training to be demonstrated effectively shall be provided.

For all instruction periods maintain training records which shall be submitted to the CA on completion. All attendee names shall be recorded and signatures obtained from all attendees confirming they have understood the training given. A schedule of names shall be provided within the operating and maintenance documentation.

All health and safety issues relating to the Works shall be brought to the attention of all attendees.

All attendees shall be provided with the appropriate Personal Protective Equipment (PPE).

Provide each person with a comprehensive set of teaching notes and diagrams.

'Formal' presentations shall be carried out over 'half day' periods.

As an indication, the training for operating staff should include, but not be limited to:

- Building services system scope (demonstrated with the aid of schematics and/or other drawings/visual aids). To include an overview of the purpose and normal operating functions of the Works and explaining the philosophy and method of control used.
- Demonstration and training (by controls Specialist) of the building control system.
- An electronic projector style 'walk through' of the operation and maintenance manuals, highlighting important areas of health and safety together with all other items of importance.
- Highlighting, demonstrating and providing delegate experience in all maintenance procedures identified in the O&M Manuals.
- Physical tour(s) of inspection of the Works illustrating aspects covered in the 'classroom' and the location of essential isolating points of all incoming services.
- Explaining and illustrating all operator alarms, their possible causes and actions required.
- Explaining all known and typical fault scenarios which are capable of being recognised and/ or rectified by the operators.
- Identifying and demonstrating all safety equipment and interlocks including all interlocks with other suppliers' systems /equipment.
- Identifying the noise levels in the various areas and highlighting the need for any protection required.
- Specifying and illustrating any hazards associated with the Works and the methods employed to deal with them.

- Providing instruction on the correct operation of plant items and the safe limits of their operation.
- Explaining the mode of operation and sequence of events resulting from both power failure and fire alarm conditions.
- Demonstrating any alarms and explaining they're meaning and possible causes.
- Highlighting any associated hazardous maintenance materials which may require special disposal considerations.
- Highlighting the signs, cause and effect of known/ possible breakdown or fault conditions.
- Indicate and demonstrate (where practicable) arrangements made for access and removal of specific items of equipment or key large or heavy subassemblies / components.
- Demonstration of the safe day to day running and maintenance of all systems, plant and equipment.
- Providing sufficient expertise to address delegate questions.

The training for the operation of the controls, monitoring or BMS installations shall include as a minimum:

- Initial training at the works of the controls supplier including hands on experience of equipment and software similar to the installation.
- Instruction on the procedures for testing and routine inspection of sensors and actuators to enable the operator to assess the nature of faults and extent of remedial action required.
- The provision of all appropriate reference and training manuals.
- Complete initial instruction prior to commissioning of the installed system.
- Site instruction on the installed system.

Together with the controls and commissioning specialists, be available for an agreed period as agreed with the CA to assist the Employer's personnel in the operation of the various systems following practical completion and occupation of the buildings.

All costs associated with the instruction of the Employer's staff and required attendance following practical completion shall be included in the contract price.

1018009 Operation of systems prior production of record documentation

Provide attendance, at no expense to the Employer, to put into service, operate 24 hours a day and maintain the systems to the Employer's requirements, including the provision of suitable competent labour, in the event that the record drawings and/or maintenance manuals are not available when the Works would, in the opinion of the CA, otherwise qualify for practical completion.

Failure to provide this service satisfactorily the Employer shall be entitled to make his own arrangements and recover the full cost through

1018010 System demonstration

Subsequent to the completion of all testing and commissioning to the satisfaction of the CA, when directed by the CA operate the plant and demonstrate that the overall systems function correctly in accordance with the requirements of the specification.

Full running and operation for a period of at least 4-hours shall be considered reasonable for this demonstration and this period shall be allowed in the programme.

During this period be responsible for the recording of results and the operation and maintenance of the plant. If appropriate, use this time to instruct the Employer's staff in the operation and maintenance of the systems.

Provide an operational report of the demonstration and print out of the conditions maintained within the space for the required demonstration period.

1019000 MAINTENANCE

1019001 Provision for 12 months maintenance

Include within the tender a separate cost item for 12 months maintenance from the date of practical completion.

Include for:

- Planned preventative maintenance of the Works to maintain the systems in efficient working order including routine checks, adjustments, lubrication and replacement of consumable spares, etc
- Preparation of work schedules and recording activities
- Providing breakdown and emergency cover
- Planned shut-downs for maintenance to be undertaken
- Employing of all necessary specialist maintenance required for the Works
- Attendance on and supervision of specialist maintenance required for the Works
- Carrying out all necessary safety checks
- Carrying out system proving of the works to include the measuring, recording, evaluating and reporting on the seasonal performance of the systems against their design values
- Monitoring and recording of all energy consumption during this period
- Water sampling including laboratory analysis and monitoring of heating, chilled, domestic water systems
- Liaison with the Employer

Submit with the tender a method statement outlining how the above is to be undertaken.

One month before practical completion submit to the CA a detailed planned preventative maintenance programme for the Works.

1019002 Proposal for annual maintenance contract

Submit within 4-weeks of request a supplementary proposal for an annual maintenance contract.

The proposal should include for:

- Planned preventative maintenance to maintain the installations in efficient working order including routine checks, adjustments, lubrication and replacement of consumable spares, etc.
- Preparation of work schedules and recording activities.
- Providing breakdown and emergency cover.
- Planning and undertaking shut-downs for maintenance works.
- Employing of all necessary specialist maintenance.
- Attendance on and supervision of specialist maintenance.
- Carrying out all necessary safety checks.
- Carrying out system proving of the works to include the measuring, recording, evaluating and reporting on the seasonal performance of the systems against their design values.
- Water sampling including laboratory analysis and monitoring of heating, chilled, domestic water systems.
- Monitoring and recording of all energy consumption during this period
- Liaison with the employer.

The proposal should set out the terms of the offer, the work to be carried out, the guarantees of performance and the price of the first 12 months after Practical Completion of the contract works or section thereof.

The proposal will not necessarily be considered as part of the contract works and the Employer does not undertake to accept it.

1019003 Maintenance of existing services

During the progress of the Works fully maintain all existing services.

Submit a method statement to the CA prior to commencement of the Works outlining how the existing services are to be maintained including all planned and preventative maintenance measures.

All costs shall be included in the contract price to maintain the existing services at all times during the duration of the contract. Include and provide any additional work and materials.

Any existing services that are disturbed or damaged by the Works are to be reinstated fully in accordance with the standards of quality as defined in the specification and to the satisfaction of the CA. Submit to the CA a method statement outlining the method and procedures for the remedial and reinstatement works.

Any shut down of existing services to undertake remedial and reinstatement works shall be to an agreed procedure and as agreed with the CA.

1020000 EXISTING SERVICES

1020001 General

The existing services are to be retained or modified in accordance with this specification and drawings.

Existing services shall not be interfered with, nor interrupted in any way without the prior written permission of the CA.

Be responsible for any damage entailed and make good any such damage to the satisfaction of the CA at no extra cost.

1020002 Scope of existing services

The existing services comprise:
Generator, fuel delivery system and electrical distribution cables

1020004 Risks to health and safety

The nature and condition of the existing services cannot be fully ascertained before commencement of the works.

The Employer or the CA do not guarantee the accuracy and sufficiency of the information provided. Undertake responsibility to obtain any information required to undertake the works and ensure the safety of all persons.

Submit a statement with the tender describing any significant and unavoidable risks which may arise as a result of carrying out the contract works and the measures proposed to safeguard the health and safety of operatives and of any person who may be affected by the contract works.

The following risks are or may be present:
Live electrical systems

1020005 Making safe of existing services

Submit to the CA method statement(s) prior to commencement of works for the making safe of the stated existing services prior to removal including:

1. Risk assessments
2. Permit to work
3. Temporary works
4. Method of removal
5. Requirements for making safe
6. Compliance with current statutory regulations, codes of practice or normal good practice

Method statements should address the particular needs of the site and should detail the planned sequences and methods of making safe and removal of the existing services. The proposed working methods should be assessed to determine whether a number of method statements are required, particularly where the operations are phased.

Method statements should be prepared in such a way that they enable supervisors and managers to ensure that persons on site are made aware of how the work should be carried out including the sequence of operations, the plant and types of equipment to be used and the precautions to be taken, as appropriate

1020006 Investigations and surveys

Undertake investigation and surveys to determine the nature of the site, existing services, local conditions and restrictions likely to effect the execution of the Works prior to commencement of the works.

Determine and define any physical site restrictions, constraints and hazards which may affect the undertaking of visual inspections, including health and safety matters.

Surveying should be undertaken in a planned, safe manner. Caution should be exercised and continual alertness should be maintained.

Assess the general condition of the existing services, based on visual inspection, and recommended if further specialist investigation is required. Examine available record drawings and documentation of the site, structures and engineering services. Discuss specific maintenance and operational procedures with the maintenance staff and operators of the existing services. Prepare a report and submit to the CA.

Take photographs of the existing installation and equipment to be removed at a quality agreed with the CA and in sufficient detail to show the condition of the equipment prior to removal.

Prior to commencement of the works survey the existing services installations to determine the necessary information in order to make safe and removal. The survey should establish:

- Extent of decommissioning;
- Condition of services with respect making safe and removal
- Function
- Size
- Material
- Location with respect to existing structure and architecture
- Safety
- Hazardous substances/materials
- Risk and presence of legionella
- Presence and removal of refrigerants
- Sequence of removal
- Presence of deleterious materials relating to the services.

On completion of the survey prepare a report and submit to the CA.

Advise on the requirement for any urgent works or required action as a result of non-compliance and any parts of the services installation found to be potentially hazardous.

Identify special training and other requirements that should be satisfied before commencement of making safe and removal of the existing services.

No claim for lack of knowledge will be allowed.

1020007 Maintenance of existing services

Fully maintain the following existing services during the progress of the Works:

Submit to the CA prior to commencement of the contract works the following:

1. Method statements outlining the method and procedure to be used for the maintenance of the existing services
2. A planned maintenance programme for the existing services
3. Details of permit to work procedures

Provide any additional work and materials necessary to maintain these services at all times during the duration of the contract works.

Any existing services disturbed by the Works are to be reinstated fully in accordance with the standards of quality defined in the specification and to the satisfaction of the CA.

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1020008 Connections to existing services

Connections to existing services shall be undertaken out of normal working hours and agreed with the CA and Employer.

Prior to undertaking the work submit to the CA for approval method statement(s) to include:

1. All necessary risk assessments
2. Permit to work procedures
3. Temporary works
4. Method and procedures for connection
5. Programme
6. Requirements for making safe
7. Compliance with current statutory regulations, codes of practice or normal good practice

1020009 Decommissioning activities

Decommissioning shall include activities that, where appropriate, take into account any earlier decommissioning work which was not completed.

Decommissioning activities shall include:

- isolation, earthing, spiking and cutting of high voltage cables at points outside the demolition area
- isolation of low and medium voltage cables not rendered dead by the actions taken above
- disconnection of cables crossing the demolition area from buildings that are not to be demolished
- disconnection and separation of emergency/standby battery systems;
- removal of bulk process or other chemicals, including battery acids and oils
- draining and purging of all pipework and vessels
- draining and purging of vessels and systems that have contained flammable or noxious gases *(any such systems should be left vented to the atmosphere and ensuring that accumulation of fluids cannot occur)*
- draining of all substantial heads of water
- isolation of water and gas supplies at points outside the demolition area, or removal of a section of the pipework and the fitting of blanks or plugs
- removal or elimination of substances that can give rise to biological, chemical, explosive or radiological hazards

1020010 Removal of existing services

The approval of the CA shall be sought prior to the removal of any existing services.

Provide to the CA prior to commencement of the contract works:

1. Method statements outlining the method and procedures to be used for the removal of the existing services including
2. Risk assessments
3. Health and safety procedures
4. Details of permit to work procedures
5. Programme for the removal of existing services
6. Details of temporary works to be provided
7. Waste management strategy

Prepare or contribute to, as required by the CA, a waste management plan in accordance with the Waste (England and Wales) Regulations 2011 or the Waste Management (Scotland) Regulations 2011 as appropriate.

Place an emphasis on re-using existing equipment where possible and carefully remove and store any equipment identified as being suitable for re-use such that the equipment suffers no damage during its removal or storage.

Where equipment is identified to be re-used or offered to the client for re-use provide all necessary protection to that equipment. Any damage to that equipment during removal or storage shall be compensated at full market value.

Take photographs of the installation and equipment to be removed at a quality agreed with the CA and in sufficient detail to show the condition of the equipment prior to removal. Do not remove any of the installation or equipment prior to agreement that the photographs are of suitable quality and detail.

Take account of the effect of existing services on other parts of the building where a full removal is not being undertaken. Undertake the coordination of the engineering services removal ensuring that no conflict with other trades occurs.

Section 2000000 – General information, standards and design criteria

2001000 GENERAL INFORMATION

2001001 Metric and imperial conversions

Some dimensions and units in metric have been converted from imperial units and approximated to the nearest practical dimension, i.e. 12 inches has been converted to 300mm. Due allowance shall be made for these conversions. Metric sizes have been used in this specification for both metric and imperial components. In certain instances only imperial components are available and generally the imperial size has been converted to the metric equivalent size

2001002 Units of measurement

The units of measurement shall be:

Measurement	Unit	Unit abbreviation
Temperature	Degrees Celsius	° C
Pressure	Kilo Pascal or Pascal	KPa or Pa
Volume flow rate	Litres per second or cubic metres per second	l/s or m^3/s
Velocity	Metres per second	m/s
Speed	Revolutions per minute	rpm
Capacity	Litre	l
Heat flow	Kilo Watt	kW
Area	Square metre	m^2
Length	Metre or millimetre	m or mm
Density	Kilogram per cubic metre	kg/ m^3
Mass/weight	Kilogram	kg
Force	Newton	N
Power	Kilowatt	kW
Current	Ampere	A
Voltage	Volts	V
Illumination	Lux	lux
Frequency	Hertz	Hz
Noise	Decibel	dB
Energy	Kilowatt hour	kWh
Resistance	Ohm	ohm
Reactive	Volt - Ampere or Kilovolt - Ampere	VAr or kVAr
Capacitance	Farad	F

2002000 STANDARDS AND REGULATIONS

2002001 General requirements

This specification is not intended to replace any published or accepted standard of compliance pertaining to the works.

2002002 Standards and regulations

The complete services installation and components shall, unless stated otherwise, comply with the appropriate British Standard (BS and/or BS EN)) or Code of Practice (CP) and where no BS or CP is applicable the Agreement Certificate for the particular item.

Ensure all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed in the same location.

All product and materials shall have product conformity certification (eg BSI Kitemark, BSI Safety Mark or CARES scheme) or product approval (eg British Board or Agrement Certificate)

All products shall have a recognised ‘CE’ mark attached.

Certificates of compliance with British Standards, BSI Certification Schemes, and/or other Quality Assurance Schemes, shall be provided to the CA when requested.

Notify all authorities in accordance with their regulations and obtain any required approvals for the Works.

In the absence of specific design, performance or installation standards being stated seek the instructions of the CA prior to commencement of the Works and with adequate time so as not to cause delay.

Comply with all statutory obligations where applicable, including, but not limited to, the following:

1. British Standard Specification (BS) and European Standards (BS EN).
2. British Standard Code of Practice (BSCP).
3. CIBSE Guides to Current Practice and Technical Memoranda
4. Institution of Engineering and Technology (IET) Wiring Regulations (BS 7671).
5. Institute of Plumbing and Heating Design Guide (IPHE).
6. Water Supply (Water Fittings) Regulations
7. Water Byelaws
8. The Building Regulations
9. Loss Prevention Council (LPC)
10. Building Research Station (BRE) digest recommendations
11. Building Services Research and Information Association (BSRIA) recommendations and guides
12. Local Bye-Laws and/or Regulations.
13. Manufacturers’ instructions and recommendations for installation/testing
14. Government (formerly PSA) specifications
15. Health and Safety at Work Act
16. CDM Regulations
17. Health Technical Memoranda (HTMs)
18. Health Building Notes (HBNs)
19. HSE Approved Code of Practice documents and guidelines
20. Radiocommunications Agency

When new editions are published during the construction, the instructions of the CA shall be sought regarding any modifications or changes necessary.

References to BSI documents shall be to the versions and amendments listed in the British Standards Catalogue and in subsequent issues of BSI News up to one month prior to the tender issue date.

Reference to a British Standard shall mean all parts or sub-sections of that standard unless stated otherwise.

The tender shall be based on the regulations and standards current one month prior to the issue date of tenders.

2002003 Copies of standards

The installer shall produce on site when requested by the CA any Code of Practice or British Standard applicable to the Works.

Some of the recently published Codes of Practice contain the following clause:

"In this Code the word "shall" indicates a requirement that is to be adopted in order to comply with the Code while the word "should" indicates a recommended practice."

2002004 Pressure directive

All pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar shall comply with the European Community (EU) Pressure Equipment Directive (PED) 97/23/EEC. Pressure equipment shall include vessels, piping, safety accessories and pressure accessories. Assemblies shall mean several pieces of pressure equipment assembled to form an integrated, functional whole.

Pressure equipment shall be marked as a minimum with:

1. Unique identification of the manufacturer
2. Unique identification of model and serial number
3. The year of manufacture
4. Maximum/minimum allowable pressure limits
5. CE marking

Provide a declaration of conformity for all pressure equipment and submit copies to the CA prior to installation into the Works. Provide copies as part of the record documentation.

Equipment must be:

1. Designed for adequate strength taking into account internal/external pressure, ambient and operational temperatures, static pressure and mass of contents in operating and test conditions, corrosion and erosion, fatigue, etc.
2. Provided with means to ensure safe handling and operation and of examination, draining and venting.
3. Provided with protection against exceeding the allowable limits of pressure.
4. Where necessary, pressure equipment must be designed and fitted with suitable accessories to meet damage-limitation requirements in the event of external fire.

Ensure all components or sub-assemblies in their finished assembly are used within their safe operating range and correctly installed and tested.

Ensure that adequate instructions are provided by the manufacture for the safe installation, testing and operation.

Instructions shall be provided to ensure for the safe maintenance and operation of the equipment when in operation.

Pressure equipment and assemblies below the specified pressure / volume thresholds must be safe and designed and manufactured according to good engineering practice.

2002005 ATEX Directive

All equipment and protective systems used in potentially explosive atmospheres shall comply with the ATEX Directive 94/9/EC.

Equipment meeting the requirements of the Directive shall have the CE symbol clearly affixed to indicate compliance.

All equipment, protective systems and components must bear the specific marking of explosion protection as required by the ATEX Directive in addition to the CE marking.

Provide an EU Declaration of Conformity prior to delivery to site as stated elsewhere.

Where a product is subject to several directives, which all provide for the affixing of CE marking, provide to the CA an EU Declaration of Conformity, prior to delivery to site, as evidence that the product conforms to the provisions of all necessary directives.

2002006 EU declaration of conformity

As requested by the CA and prior to delivery provide an EU Declaration of Conformity for all equipment. The declaration shall state the following as a minimum:

1. The manufacturer or their authorised representative
2. Description of equipment
3. The harmonised standard(s) that have been applied
4. The signatory who has been empowered to enter into commitments on behalf of the manufacturer
5. The last two digits of the year in which the CE marking was affixed

Where only a Declaration of Incorporation for component parts of the assembly can be provided advise all aspects to be considered to enable others to provide a Declaration of Conformity

2002007 Electromagnetic compatibility

All equipment and systems installed shall provide electromagnetic compatibility within the system and with any other systems installed in the same area.

All systems and buildings shall be assessed for protection to, and such protection shall meet the requirements of:

BS EN 61000	Electromagnetic compatibility (EMC)
BS EN 55015:2006+A2:2009	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
BS EN 60870	Telecontrol equipment and systems
BS EN 55024:1998+A2:2003	Information technology equipment. Immunity characteristics. Limits and methods of measurement
BS EN 12015	Electromagnetic compatibility. Product family standard for lifts, escalators and passenger conveyors. Emission.
BS EN 12016:2004+A1:2008	Electromagnetic compatibility. Product family standard for lifts, escalators and passenger conveyors. Immunity.

All equipment shall meet the requirements of the appropriate electromagnetic compatibility standard.

All electrical and electronic apparatus shall comply with the EMC Regulations 2006 and must carry the CE Marking to demonstrate compliance.

2004000 DESIGN CRITERIA

2004001 General

The design of the engineering services is based on the parameters and design data stated in the following clauses and these shall not be changed or amended without prior written notice from the CA.

2004003 Atmospheric corrosivity

The external atmospheric environmental corrosivity category shall be C3 as defined by BS EN ISO 12944 and ISO 9223.

Categories as defined by BS EN ISO 12944 are as follows

Corrosivity category	Corrosion risk	Examples of typical environments in a temperate climate *(informative only)*	
		Exterior	**Interior**
C1	Very low		Heated buildings with clean atmospheres, eg offices, shops, schools, hotels.
C2	Low	Atmospheres with low level of pollution. Mostly rural areas.	Unheated buildings where condensation may occur, eg depots, sports halls.
C3	Medium	Urban and industrial atmospheres, moderate sulphur dioxide pollution. Coastal areas with low salinity.	Production rooms with high humidity and some air pollu-tion, eg food processing plants, laundries, breweries, dairies.
C4*	High	Industrial areas and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal ship- and boatyards.
C5-I	Very high (industrial)	Industrial areas with high humidity and aggressive atmosphere.	Buildings or areas with almost permanent conden-sation and with high pollu-tion.
C5-M*	Very high (marine)	Coastal and offshore areas with high salinity.	

2004025 Internal lighting

The levels of maintained horizontal illumination shall be:

Room or area	Illumination level (lux)	Minimum uniformity across working plane (minimum to average)	Minimum reflectances (%)		
			Walls	Ceiling	Floor
Generator Container	250				

Lighting illumination levels shall be designed to meet but not significantly exceed the maintained illuminance levels as recommended by the Society of Light and Lighting.

All luminaires with fluorescent and other discharge lamps shall be equipped with high frequency ballasts.

Contractor proposals based on 6 month cleaning regimes will not be accepted.

2004026 External lighting

External lighting shall be installed so as to minimize the upward light component

All external lighting shall be timer and daylight sensor controlled

The external lighting shall not exceed the following average levels of illumination:

Area/space	Illumination level (lux)	Minimum uniformity (minimum to average)
Circulation and approach areas	50	

2004027 Emergency lighting

Emergency lighting installations shall comply with the requirements of BS 5266 and BS EN 1838 The levels of illumination for a period of 3-hours shall be as follows:

Area/space	Illumination level (lux)	Minimum uniformity (minimum to average)
Generator Container	100	

2004030 Lightning protection

Lightning protection shall comply with BS EN 62305

2004031 Fire alarm systems

The fire alarm system shall comply with BS 5839.

The fire alarm system shall be to Type L1 or where applicable, the fire alarm shall be in accordance the recommendations of the fire engineering strategy.

2004043 Spare Capacities

The electrical infrastructure shall include spare capacity as follows: 25%

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The engineering services installations shall be designed to include the following spare capacities: 25%

All low voltage switchboards shall have spare cubicles containing a minimum of two 800A MCCB or ACB's as spare for future connections. A reasonable spare shall be provided for future expansion.

- All final distribution boards and motor control centre panels (MCCPs) shall have provision to accommodate an additional 25% MCCB/MCB for future expansion
- The Building Management System (BMS), components, and installation shall incorporate at least 25% expansion without redundancy

2006000 GENERAL WORKMANSHIP AND STANDARDS

2006001 Working temperatures, operating and test pressures of services

Equipment, pipework, fittings, valves, coils, vessels and other pipeline ancillaries including joints and jointing methods shall be suitable for the working temperature and operating pressures of the systems applicable. Working pressures of materials and plant shall be de-rated where appropriate to suit the operating temperature in accordance with the manufacturer's recommendations and the appropriate British Standard or Code of Practice.

In addition to the above operating requirements they shall also be suitable to withstand the test pressures defined elsewhere without damage and undue stress.

A schedule of working temperatures, operating pressures and test pressures shall be submitted for approval before any orders are placed.

No material or equipment shall be used where the maximum de-rated operating pressure or test pressure is at its limit and would not adequately withstand a fluctuating increase in system pressure of at least 10%.

2006002 Consistent material supplies, quality and finish

Materials shall be of a consistent manufacturer and standard. Each type of material item, or range of material items shall therefore be of a single manufacture.

Unless specifically stated, material items shall be of the same finish and/or quality and/or grade as the system within which they are installed.

2006003 Materials and equipment

Materials, equipment and expendable sundries shall be supplied and purchased new from and no second hand, reconditioned or overhauled equipment shall be allowed.

Ensure all plant, equipment and materials are protected against damage or adverse weather conditions until practical completion. Any plant equipment or materials that have been subjected to damage, incorrect storage or incorrect installation will require to be replaced at no cost to the contract.

2006004 Access facilities

All access facilities shall be located such that they are easily accessible, fit for their purpose and in compliance with health and safety regulations. Health and Safety of maintenance staff must be considered.

No plant or equipment is to be installed in such a manner that it cannot be routinely and regularly maintained in a safe manner. No plant is to be installed such that longer term maintenance or the replacing of parts is impractical or likely to cause undue expenditure. No plant access points are to be obstructed.

Access requirements are generally described and detailed elsewhere in the specification but the following minimum requirements must be provided.

Plant and Equipment
Access facilities shall be provided to all items of plant and equipment. The requirements for access shall be established with the manufacturer and indicated as clear unobstructed space on the co-ordinated installation drawings.

Walkways, access platforms, ladders and lifting gear shall be provided if necessary.

Access is required for:

1. Regular maintenance, fabrication or adjustment.

2. Replacement of parts
3. Monitoring plant conditions
4. Cleaning

Prior to practical completion demonstrate to the CA that all plant and equipment have adequate access facilities.

Ductwork Systems
Provide access where frequent cleaning shall be necessary in the form of 450mm x 380mm access panels at a minimum of 3m intervals, positioned to enable internal cleaning of all ductwork components. On horizontal ducts the bottom of the opening shall be level with the bottom of the duct to enable easy sweeping out.

Access panels shall be so positioned as to enable cleaning personnel to easily reach the inside of the duct.

Provide access for inspection of ancillaries concealed in ductwork, including but not limited to:

1. Control dampers
2. Fire dampers
3. Control devices
4. Turning vanes
5. Heating/cooling coils (both sides)
6. Provide access to plant connections including but not limited to:
7. On inlet ducts to wall or roof mounted extract fans
8. Either side of axial flow fans
9. External louvres
10. Access for testing including provision of test holes
11. Access for commissioning/testing - ensure all control dampers are easily accessible, provide access panels in ceilings if necessary.

Pipework Systems
Provide access for venting and draining

Provide access for water treatment additions

Access for commissioning/regulating - Ensure all commissioning stations, strainers and isolating valves are easily accessible, provide access panels in ceilings if necessary.

Locate all ancillaries including control valves, isolating valves in positions where routine access is easily achieved.

Access for cleaning and rodding wastes, stacks, vents and drains

On new sanitation pipework access shall be provide at the head of horizontal runs of soil and waste pipes, on top of stub stacks, on vertical pipes passing between floors, on horizontal suspended pipes above ceilings and immediately prior to connecting to existing soil and waste stacks. Where alterations to the building comprise existing access points provide alternative suitable access.

Access points shall take the form of proprietary bolted or screwed fittings with seals.

2006005 Services installed in ducts, trenches, subways etc

Engineering services included in the works shall be installed generally as detailed or stated elsewhere and to recommendations in BS 8313 for accommodating services in ducts.

2006006 Facilities for the removal of equipment

Services connections to equipment, and plant, shall be made with decoupling adjacent to the equipment such that any removable section, cover or the complete unit can be readily

removed or withdrawn without the removal or disturbance to large sections adjacent services systems.

In addition it shall be possible to isolate and drain down any item of equipment without isolating large sections of the remaining system.

2006007 Removal of pipework

Pipework shall be installed with sufficient flanged and/or union joints to facilitate easy removal of any part of the system at a future date. Flanged and/or union joints shall be provided at intervals not greater than 16m along all straight runs of pipework.

In plantrooms, services ducts, false ceilings and other similar areas, flanged and/or union joints shall be provided at suitable locations to facilitate removal of pipework in sections.

2006008 Prevention of electrolytic action

Metal pipework conveying water shall be protected from electrolytic action by the installation of non-conductive or fibre type nipples to mechanically separate copper pipes from galvanised tanks or galvanised steel pipework.

In the case of acidic water, approval shall be obtained of the protection required to avoid possible corrosion due to electrolytic action.

2006009 Prevention of dezincification

Brass fittings shall not be used where there is a risk of dezincification or stress corrosion.

Approval shall be obtained prior to ordering materials that may be affected by dezincification and the correct materials shall be used throughout the system.

2006010 Services crossing building expansion joints

At points where services cross the building expansion joints flexible connections, compensators, or expansion joints shall be provided to accommodate the building movement within the services installation unless it can be demonstrated that there is sufficient flexibility in the pipework installation.

Brackets and supports each side of the flexible joint shall be so arranged that the services crossing the building expansion joint remain symmetrical and correctly aligned.

2006011 Frost protection of pipework and services

Pipework in exposed positions shall be protected from possible frost damage by means of thermal insulation of adequate thickness and suitable finish.

Where thermal insulation is not practicable or insufficient to prevent freezing electrically heated tracing cables around the pipework shall be provided, in addition to thermal insulation, controlled by a clamp on type thermostat and wired to an adjacent electrical supply point.

The protection of pipework against frost damage shall comply with BS 6700:2006+A1:2009

Trace heating shall be provided to the following:

1. External chilled water services
2. External above ground mains water services
3. External above ground cold water services

Trace heating shall consist of self-limiting heating tape. An external air temperature thermostat shall energize the tape when the temperature falls below 2°C. A permanent electrical supply and field wiring shall be provided from the nearest motor control centre or distribution board.

2006012 Protection of buried services

Wrapping 2 coats of petroleum jelly impregnated tape or similar approved material around the pipe and pipeline ancillaries shall protect services of ferrous metal and copper that are buried directly within the ground or surrounded or bedded in concrete.

2006013 Site Personnel Records of Works and Identification of Work

The Quality Assurance Procedures undertaken by the Contractor, and his Specialist Traders where applicable, shall include a suitable methodology and recording procedure, which shall enable the craftsman or workman responsible for any work to be identified.

For example: The Contractor shall keep on site an up-to-date set of as installed drawings upon which shall be marked in ink the work done by each pipe fitter.

The records shall be incorporated into the record documentation.

2006014 Rubber matting

Black rubber strip floor matting shall be installed in front of switch panels and control panels. The matting shall be manufactured in accordance with BS 921 and neatly cut to the dimensions required and laid in an approved manner.

2006015 Welding

General
The CA will place a strong emphasis on the standard of welding and the associated quality control procedures in order that the welding meets the required standards in all cases.

All welding shall be executed by competent qualified/certified welding operators fully experienced in the type and size of welding being carried out.

All welds shall be permanently marked with the welder's individual identification code placed adjacent to each completed weld. A log of all welders, their qualifications and a record of the work carried out by them shall be kept on site at all times and shall be available for inspection.

Any weld not permanently marked with a welder's individual identification code shall be examined by an independent inspection authority to include both visual and non-destructive testing. Should testing fail the weld shall be cut out and replaced at no cost to the contract.

An approved independent inspection authority acting as sole arbiter shall carry out all visual and non-destructive examination. Personnel engaged in radiographic, magnetic particle or ultrasonic examination and interpretation shall hold appropriate NDE certification which shall be submitted to the CA prior to commencement of the Works.

To enable the independent inspection authority to realistically cost their work the installer shall, during the tender period, send to the Independent Inspection Authority all necessary information to facilitate costing. Details of the independent inspection authority shall be submitted with the tender.

Prior to completion of the Works submit to the CA a statement signed by the independent specialist responsible for welding examination and non-destructive testing stating compliance with the requirements of the specification.

All examination and testing of welds together with the resulting remedial work shall be at no additional cost to the contract.

Care shall be taken during welding operations that the welding metal or flux does not project into the bore of the pipe. Welds shall be of good clean metal, free from slag inclusions and porosity, of even thickness and contour, well fused with the parent metal, annealed and finished smooth.

Where tack welds are used to secure alignment, there shall be four equally spaced and to the same standard as the final weld, this is, they shall have full penetration at the throat, vee or fillet and be of a length equal to twice the pipe wall thickness.

Manufactured welding fittings shall be used as far as possible and shall be black mild steel butt welded type complying with the relevant standards.

Immediately on completion every weld shall be painted with zinc chromate paint.

Standards and codes
All welding shall be in accordance with all relevant standards and codes, including but not limited to:

BS EN 287-1	Approval testing for welders for fusion welding – Steels
BS EN 970	Non-destructive examination of fusion welds – Visual examination
BS EN 1435	Non-destructive examination of welds – Radiographic examination
BS EN 1714	Non-destructive examination of welded joints – Ultrasonic examination
HVCA TR5	Welding of carbon steel pipework – Code of Practice
BS 2633	Specification for class I arc welding of ferritic steel pipework for carrying fluids
BS 2971	Specification for class II arc welding of carbon steel pipework for carrying fluids
BS EN ISO 9934	Non-destructive testing. Magnetic particle testing

Welder approval
All welders shall hold valid welder approved certification. A welder approval certificate shall be valid for such period as defined by the issuing body.

Copies of current welding certificates for all welders shall be presented for examination by the CA before any works are commenced.

Only certified welders providing acceptable samples shall be permitted to weld.

Welders holding BS EN 287-1 certification shall be limited to the range of approval stated on the certificate with regard to welding process, welding position, material groups, pipe wall thickness and pipe diameter.

Prior to commencement of the Works, welders shall perform sample welds for the inspection by an approved independent specialist in accordance with necessary standards. Each welder shall carry out the Abbreviated Tests specified in Appendix III of the HVCA: TR5 Document to the satisfaction of the Independent Inspection Authority.

The welder's qualifications shall be in accordance with BS 2971 or BS 2640 as applicable and their approval tests in accordance with BS 4872 Part 1. Welder qualifications shall be reviewed and approved by the independent inspection authority. A current HVCA Test Certification is acceptable in lieu of the foregoing.

For pipework in category 2 of the Pressure Equipment Directive 97/23/EC, welding procedures shall comply with EN 288 part 3 or ISO 15614. Welder qualifications shall comply with BS EN 287 part 1.

Approval testing does not exempt compliance with the fault limitations shown in BS 2971 or BS 2640.

Failure to satisfy the independent inspection authority as to the competence of any welder craftsman shall result in that craftsman being tested in accordance with BS 4870 and BS 4871 as applicable prior to that craftsman commencing or continuing to work. Failure of any craftsman to complete such tests to the satisfaction of the independent inspection authority shall result in that craftsman ceasing all welding work.

Weld quality
All welds shall be visually examined to BS EN 970 on the outside surface and, where practicable, in the bore with the aid of optical instruments if necessary by an approved independent specialist.

Inspection reports detailing welding inspection activities formed during that period shall be submitted to the CA at weekly intervals.

Non-destructive examination shall be used progressively during the installation of the Works as part of quality control.

Non-destructive examination reports shall indicate either the acceptance or rejection of welds. Test reports including radiographs where appropriate shall be submitted to the CA. Remedial action shall be agreed with the CA before commencement of these works.

Over and above the testing of each welder's work a number of random tests shall be carried out. Non-destructive testing shall be undertaken on approximately 10% of all butt weld joints and 5% of all other joints. Non-destructive testing shall be evenly distributed over the whole of the Works and shall be evenly split between all welders employed on the Works.

Installed welds to a maximum number of 3% of total or 10 number shall be removed to enable a thorough inspection to take place.

10% of all gas and oil pipework joints shall be radio-graphically tested, subject to the specific requirements of relevant standards.

Should any weld fail then a further 15 welds shall be subject to radiographic testing.

Should any of the second batch of welds fail then the CA shall have the right to instruct the cutting out and replacement of all welds and the replacement of all welders previously employed on site at no additional cost. The installer shall take all necessary measures, subject to agreement with the CA, in order that subsequent welding shall be in compliance with the required standards.

If a considerable proportion of welded joints by a particular operator are found to be unacceptable, all welds by this welder shall be completely removed and replaced at no additional cost.

The number of random tests shall also apply to all welds completed off-site by pre-fabricators.

Failure of any one welder’s work shall result in 10 more of their welds being tested as selected by the independent inspection authority or CA. Failure of any of these shall result in all of that person’s work being tested at the installer’s own cost.

If the installer introduces different welder craftsmen after the stipulated number of tests on welds have been undertaken the installer shall at his own cost have at least 5 samples of each such craftsman’s work tested.

A statement shall be submitted to the CA prior to practical completion to confirm compliance with the welding quality requirements of this specification. The statement shall be signed by the independent inspection authority.

Radiographic Testing
Radiography shall be limited to the examination of butt welds.

Radiographic non-destructive tests shall be carried on a percentage of all welds as stated and selected at random during the course of construction by the inspection authority and agreed with the CA.

Radiographic examination shall be undertaken in accordance with BS EN 1435.

The regulations regarding ionising radiation hazards to site personnel and the public must be adhered to. Permission from the HSE must be gained at the commencement of the Works,

A method statement, clearly defining the preparation and methodology of the tests shall be submitted to the CA for approval prior to the testing.

The radiographic testing shall be evenly distributed over the whole of the works and shall be evenly split between all welders employed on the works on a pro-rata basis.

Radiographic test operators shall be qualified to PCN Level 2 or ASNT Level 2 and shall be approved by the independent inspection authority along with examination reports.

Submit examination reports to the CA.

Ultrasonic Testing
Where radiographic testing is prohibited on site, ultrasonic testing shall be undertaken in lieu. Where the use of ultrasonic examination is agreed it shall be undertaken in accordance with BS EN 1714

A method statement, clearly defining the preparation and methodology of the tests shall be submitted to the CA for approval prior to the testing.

All ultrasonic testing operators shall be qualified to PCN Level 2 or ASNT Level 2. The independent inspection authority shall review all ultrasonic testing operator qualifications and examination reports.

Submit examination reports to the CA.

Magnetic particle examination
Where the use of magnetic particle examination is agreed, it shall be undertaken in accordance with BS EN ISO 9934-1.

10% of all fillet welds made in ferrous materials shall be examined by magnetic particle inspection. Similarly, 10% of fillet welds made in non-ferrous materials shall be examined by Dye Penetrant Inspection (DPI).

All magnetic particle and dye penetrant inspection operators shall be qualified to PCN Level 2 or ASNT Level 2. T

The independent inspection authority shall review all magnetic particle and dye penetrant inspection operator qualifications and associated examination reports.

Submit examination reports to the CA.

2006016 Brazing and bronze welding

The CA will place a strong emphasis on the standard of brazing and the associated quality control procedures in order that the required standards are achieved in all cases.

Brazing and bronze welding shall be executed by competent qualified/certified operators fully experienced in the type and size of work being carried out.

Brazers shall hold a valid certificate of competency issued by an approved body. Brazers without valid certificates and those without relevant brazing work experience within the preceding three months shall undertake an approved competency test, witnessed and

certified by an approved body. A copy of certificates shall be submitted to the CA before any works are commenced.

A log of all brazers, their qualifications and a record of the work carried out by them shall be kept on site at all times and shall be available for inspection.

If so requested by the CA, and prior to commencement of the Works, brazers shall perform samples at all sizes for the inspection of the CA. Only certified brazers providing acceptable samples shall be permitted to undertake the works.

Copper joints shall be silver soldered, brazed or bronze welded to suit the operating temperature and pressure and shall comply with BS EN 14324.

In addition the recommendations of the HVCA and Copper Development Association shall be adhered to.

Welding rods, brazing filler materials, fluxes etc, shall comply with relevant British Standards.

Brazers shall permanently identify each of their joints with their own unique mark which will withstand site conditions without damaging system or component performance. Methods of marking shall be approved by the CA prior to commencement of the works.

During the installation of the Works the CA shall select at random installed brazed joints to a maximum number of 3% of total or 10 number and the installer shall remove these to enable a thorough inspection to take place. In the event of finding a faulty joint a further 10 joints made by the relevant brazer shall be cut out and tested. Should any of the second batch fail then the CA shall have the right to instruct the cutting out and replacement of all brazed joints and the replacement of all brazers previously employed on the site. Cutting out and consequential rectification works shall be carried out by the installer at no expense.

Visual examination and non-destructive testing of joints shall be carried out by an independent specialist approved by the CA prior to commencement of the works.

Section 3000000 – Mechanical engineering services

3201000 PIPEWORK AND FITTINGS

3201001 General requirements

Pipework shall follow the routes and approximate positions indicated on the drawings.

Pipework, ancillaries, valves and demountable joints shall be installed for convenient and safe routine maintenance and renewals.

All pipework shall be installed with adequate gradients to facilitate draining and venting.

Pipework shall be run in a neat manner and installed plumb, straight, symemetrical and at right angles to or parallel to adjacent walls.

No joints shall be formed in wall or floor thicknesses.

All pipework, fittings and valves shall be free from corrosion, scale and internal obstruction.

Pipework ends shall be cut square, reamed, free from burrs and finished full bore.

Sufficient unions and flanged joints shall be provided to install and dismantle sections of pipework, wherever difficulty in dismantling may occur and on straight runs of more than 25m.

Unions or flanges shall be provided at all valves and equipment for easy dismantling. Connections to coils, pumps, and other equipment shall be made in such a manner as to eliminate undue strains in piping and equipment. Necessary fittings and bends shall be furnished to avoid springing of pipes during assembly.

Care shall be taken in placing unions to allow freedom to spring apart. Unions and flanges shall not be placed in inaccessible positions. Where pipework is installed in inaccessible places, a union or flange shall be installed, prior to the pipe passing into the wall or floor. Unions shall have two bronze conical seats ground in. Long screw connections will not be accepted.

Piping shall be installed to allow for expansion.

All black mild steel pipework in wall chases shall be welded throughout with flanged joints at 16 m maximum intervals if applicable.

Manufacturer’s standard fittings shall be used and fabricated fittings will not be accepted without approval.

Bends and tees shall be of the easy sweep type, except at air vents, drain points and dead legs where square tees shall be used.

Changes in diameter of horizontal pipework shall be formed eccentrically.

Prior to any work being "covered up", the installer shall request the CA's approval to that part of the installation in question.

Pre-fabricated pipework shall be in accordance with the relevant clauses.

Take appropriate means to prevent galvanic action where dissimilar metals are connected.

The contractor shall obtain approval from the Local Water Authority or Water Research Centre for materials used in water supplies.

The contractor shall carefully plan the location of valves and any component requiring planned maintenance so that they are easily accessible once the installation is complete.

Pipes shall be supplied in lengths suitable for manual handling.

3201002 Protection during construction

Adequate storage facilities shall be provided to ensure that tube does not suffer any deterioration from the 'as new' delivered condition.

During construction work care shall be taken to prevent any foreign matter entering the pipework either in storage or during installation.

Open ends shall be capped with the appropriate pipework fitting. Wooden plugs and the like shall not be used.

Valves fitted on the ends of pipework shall not be accepted as a means of preventing the ingress of foreign materials.

Failure to comply with these requirements shall mean the CA shall have the right to instruct that pipework so left uncovered to be dismantled for such lengths as the CA requests and the pipework blown through and/or cleaned at no cost to the contract.

Remove all cement adhering to pipework surfaces and brackets.

Remove scale, rust by wire brushing and paint pipework and brackets as stated elsewhere in the specification.

3201003 Pipework spacing

Pipe runs shall be spaced in relation to one another, other services and the building structure. Ensure adequate space for access to pipe joints, etc and allowance for the specified thickness of thermal insulation.

The following are recommended as minimum clearances in the spacing of pipe runs:

Description	Minimum distance
Between insulated or un-insulated pipeline and wall finish	25 mm
Between ceiling finish or soffit	50 mm
Above floor finish	50 mm above top of skirting or 150 mm whichever is greater
Between adjacent pipelines	
• both insulated	25 mm
• one insulated, one un-insulated	75 mm
• both uninsulated	150 mm
Insulated pipes to adjacent conduit or tunking	50 mm
Un-insulated pipes to adjacent conduit or trunking	100 mm
Adjacent electrical cables not in conduit or trunking	150mm

3201004 Steel pipework

Pipework up to and including 150mm. nominal bore shall be carried out in black mild steel heavy quality mild steel tube to BS EN 10255. Above this bore, carbon steel pipes shall comply to BS EN 10216-1 and BS EN 10217-1

Pipework 50mm. nominal bore and below for screwing shall be supplied in random lengths having screwed ends.

Where screwed pipework joints are used, only tapered threads as BS 21 and BS EN 10226-1 will be accepted. The joints on heating pipework shall be clean threaded, pulled up tightly and made with an approved jointing compound and long stranded fine hemp. After joints have been formed, all surplus hemp shall be cut away and the joint wiped clean ready for painting.

Where pipes are held in vices when screwing or jointing, care shall be taken to ensure that the surface of the pipe is not damaged. Any pipework so damaged will not be accepted and if installed shall be replaced.

Flanges shall comply with BS EN 1092 -1 to the appropriate dimensions (for the specified pressure rating) given in tables 6 to 13.

Screwed fittings on steel piping shall be best quality malleable cast iron banded or beaded pattern to BS 143 and BS 1256 and external screwed tapered thread to BS 21 and BS EN 10226-1. Certain fittings which have parallel threads shall be to BS EN ISO 228-1.

Long screw connections, running nipples, reducing nipples, backnuts, shall not be accepted.

All bends and tees shall be of the long sweep pattern; elbows and square tees shall not be permitted on pumped systems. Also bushed fittings shall not be permitted on pipelines.

Where unions are used these shall have bronze spherical seats suitably ground in; flat seated unions shall not be permitted.

Pipework for welding shall be supplied with plain ends, joints being made with butt welds on site.

The installer shall allow only for electric arc welding for pipework above 100 mm bore. Pipework below 100mm bore may be oxyacetylene or electric arc welded

Pipework with a nominal bore of 65mm. and above shall employ flanges for jointing at periodic distances. Where flanges are used these shall comply with BS EN 1092 and to the table suitable for the working pressure of the system. Flanges shall be machine faced and trimmed at the edges. All joints shall be flush and shall use full face Taylor's corrugated rings coated with approved jointing compound. All flanges shall be fillet welded to the pipework.

Any branches made into 20mm. and 15mm. pipes shall be by drilling and reamering, not welded. Where branch welds and shoes are utilised these will not be allowed unless the branch weld is at least two sizes less than the main size. Welding metal or flux shall not project into the pipe bore and shall be finished clean, smooth and of even thickness.

Remove scale, rust and temporary protective coating and paint with one coat of red oxide primer, as work proceeds.

3201005 Copper pipework (above ground)

Copper tube shall conform to BS EN 1057:2006+A1:2010

Fittings for copper pipework shall be either:

Copper or cast gunmetal capillary type to BS EN 1254. Only lead free soft solder will be permitted for capillary type joints.

Capillary type to BS EN 1254 suitable for waste services. Tees, crosses and bends shall be 45º or 88½ º sweep type.

Where bends of other angles are required or where more suitable, formed bends in copper tubing shall be used.
Formed bends to copper piping shall be made with the use of springs or an efficient bending machine and shall be made with the minimum loss of local wall thickness. They shall maintain the diameter of the pipe and shall not involve rippled or scored work.

End feed capillary fittings shall not be permitted.

Fittings above 54mm. diameter shall be prefabricated in light gauge copper tube as specified above using machine made bends and silver brazed swept branch connections.

Brass compression fittings shall comply to BS EN 1254.

Screwed joints on copper pipework shall be provided where specified and at screwed valves and fittings. Screwed joints shall have taper threads complying with BS 21 and BS EN 10226-1.

Jointing materials shall be approved by the CA prior to commencement of the Works. The installer shall obtain the approval from the local Water Authority for all jointing materials to be used.

3201006 Copper pipework (laid in ground)

Copper pipework, where laid in the ground shall be copper tube to BS EN 1057:2006+A1:2010 - R250 (class Y) and shall be jointed with copper or cast gunmetal, capillary type fittings.

All pipework shall be protected by wrapping with two layers of Denso tape or equal and approved.

Only lead free soft solder will be permitted for capillary type joints.

3201007 Copper pipework (installed within screed)

Copper pipework where laid in a concrete screed shall be plastic coated, pre-insulated copper tube to BS EN 1057:2006+A1:2010 - R250 (class X)

No fittings are to be installed within the screed, and all bends are to be pulled.

3201008 Stainless steel pipework

Joints shall be made using proprietary push-fit fittings with seal rings that are completed using a proprietary clamp/pressing tool.

Pipework shall be installed in light gauge stainless steel tube to BS EN 10312.

Jointing shall be means of unpolished chromium plated compression type fittings.

Where bends or angles are required, then formed bends in the stainless steel tubing shall be used.

Stainless steel tubing shall not be used where pressures exceeds 13 bar.

3201009 Polyethylene pipe (laid in ground)

Installations shall be carried out using medium density polyethylene (MDPE) Series SDR II pipe and fittings coloured blue (potable water services), black (non-potable water services) and yellow (gas services).

MDPE pipework for pressurised potable water systems shall be manufactured in compliance with Water Industry Specification (WIS) WIS 4-32-17 and BS EN 12201.

MDPE pipework for pressurised non-potable water systems (excluding reclaimed water) shall be manufactured in compliance with WIS 4-32-17 and BS EN 13244.

MDPE pipework for pressurised non-potable re-claimed water systems shall be black with longitudinal green stripes marked ‘Reclaimed Water’ and manufactured in compliance with WIS 4-32-17 and BS EN 13244. Installation of pipework associated with reclaimed water systems shall follow the guidance contained in the Water Regulations Advisory Service (WRAS) Guidance Note IGN 9-02-04.

MDPE pipe for natural gas systems shall be manufactured in compliance with British Gas/Transco specifications GBE/PL2 Parts 1 & 6 (up to 5.5 bar) or Part 8 (up to 7 bar).

MDPE fittings for gas systems shall be manufactured in compliance with specifications BGE/PL2 Parts 2 & 3.

Pipework shall be jointed using approved proprietary electro-fusion of butt weld methods carried out by competent personnel suitably trained.

MDPE (PE80) pipe shall not be used where the temperature of the transported medium, be it gas or water will rise above the maximum recommended by the manufacturer for the given installation method.

MDPE (PE80) pipe shall not be used downstream of any gas booster or compression set.

3201010 Galvanised mild steel pipework

Medium and heavy grade galvanised steel pipework shall conform to BS EN 10255.

Fittings on 150 mm and below shall be galvanised malleable cast iron fittings conforming to BS 143 and BS1256 with screwed joints to BS 21 and BS EN 10226-1:2004

Fittings on pipework 175 mm and above shall be 45° and 90° long radius elbows, 180° return bends, caps, eccentric reducers and branch bends to BS EN 10253-1 to the same quality and thickness as the tube.

Care shall be exercised when threading the tube to ensure that threads are carefully cut to minimise the number of exposed threads.

Where galvanised steel pipework and screwed fittings are used on domestic hot and cold water services, including cold water mains, joints shall be clean threaded, pulled up tightly using PTFE tape (Boss Permanite GT) and a suitable jointing compound as approved in the current "Fittings and Materials Directory" as published for the Water Research Centre. On cold water services, including cold water mains, ‘Boss Blue’ jointing compound is approved and recommended.

Stranded hemp and Boss white shall not be used under any circumstances.

3201011 Cast iron pipework

Cast iron soil, waste and ventilation pipework and fittings shall be installed using coated standard grade cast iron complying with the requirements of BS 416.

All cast or ductile iron pipes and fittings shall be subjected to the optional hydraulic test at the manufacturers works as referred to in the British Standard Specification.

Cast iron below ground drainage pipework and fittings shall be installed using coated cast iron complying with the requirements of BS 437.

The jointing method of the pipework and fittings shall be either:-

Socket and spigot pipework and fittings jointed using hemp spun yarn and run molten lead well caulked and finished flush with the socket rim.
Spigot ended pipe and fittings:-

Glynwed "Timesaver" system jointed using two piece cast iron bolted couplings and synthetic rubber gaskets.

Glynwed "Ensign" system jointed using one piece ductile iron bolted couplings and synthetic rubber gaskets.

Stanton and Stavely "Stanflex" system jointed using two piece ductile iron bolted couplings and nitrile rubber gaskets.

Stanton and Stavely "SMU" system jointed using one piece stainless steel couplings with EPDM elastomer flexible gaskets.

All couplings used with plain ended spigot pipe and fittings shall be installed in strict compliance with the manufacturers' instructions. All bolts shall be tightened to the correct torque as specified and only pipe, fittings and couplings manufactured to the system specified shall be used throughout the installation. Any connection to existing pipework or fittings shall be undertaken using the correct transitional coupling.

Above ground and suspended below ground double spigot ended pipe and fittings, jointed with a bolted coupling shall be fitted with an electrical earthing continuity clip at every joint to comply with the latest edition of BS 7671.

3201012 Cast iron water main

Cast iron water main where laid in the ground shall be carried out in metric size ductile iron pipe and fittings to BS EN 545 having 'Tyton' spigot and socket joints.

Jointing and installation shall be in accordance with the manufacturers' instructions.

Concrete thrust blocks shall be included where necessary at changes in direction, tee pieces and blanked ends. Thrust blocks shall be installed prior to filling and testing of the water main.

3201013 Plastic soil and waste pipework

Soil, waste and ventilation pipework, 75mm. diameter and above shall be installed, using PVC-U pipe and fittings complying with BS EN 1329-1.

Waste and anti-syphon pipework, 50mm diameter and below, shall be installed, using PVC-U pipe and fittings complying with BS EN 1329-1.

All fittings shall be of compatible materials of the same manufacture, with solvent weld or seal ring joints, and are to be stored, assembled, supported and tested in accordance with the manufacturer' instructions.

Where jointing to different materials, the correct transitional fittings shall be used in accordance with the manufacturer's instructions.

3201014 Refrigerant Pipework

The installation shall be executed by competent qualified/certified refrigerant operators fully experienced in the type of work being carried out.

Copper tube shall be suitable for the operating pressures that will occur throughout the system.

Copper tubes for refrigerant pipework shall comply with BS EN 12735 and shall be suitable for the refrigerant and oil used.

Pipework shall be dry, completely free from scale and internally degreased.

The number of joints shall be kept to a minimum and the longest possible lengths of copper pipe shall be utilized where possible.

The installation shall comply with BS EN 378.

Refrigeration pipework joints shall be brazed or silver soldered. Joints shall be kept to the absolute minimum. Formed bends shall be used in preference to fittings.

Flared or screwed joints shall only be used with the approval of the CA.

The CA will place a strong emphasis on the standard of brazing and the associated quality control procedures in order that the required standards are achieved in all cases.

Brazing and bronze welding shall be executed by competent qualified/certified operators fully experienced in the type and size of work being carried out. Brazers shall hold a valid certificate of competency issued by an approved body. Brazers without valid certificates and those without relevant brazing work experience within the preceding three months shall undertake an approved competency test, witnessed and certified by an approved body. Submit a copy of current certificates for all brazers for examination by the CA before any works are commenced.

Copper joints shall be silver soldered, brazed or bronze welded to suit the operating temperature and pressure and shall comply with BS EN 14324. In addition the recommendations of the HVCA and Copper Development Association shall be adhered to.

Appropriate refrigeration installation tools must be utilised.

The ends of the pipework shall be cleaned and reamed out to the original internal diameter before brazing.

Dry nitrogen shall be passed continuously through the pipework at minimal pressure and at an adequate velocity during brazing or soldering to eliminate internal oxidation. All excess solder and flux shall be removed on completion of joints.

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 un-blanked longer than necessary for installation.

The ingress of moisture, dirt and any other contaminants to the interior of pipework and other components shall be prevented during storage.

Arrange all exposed pipe runs to present neat appearance, parallel with other pipe or service runs and building structure. Ensure all vertical pipes are plumb or follow building line.

Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc.

On completion of all site joints but immediately before connecting to the system components high pressure nitrogen shall be flushed through the pipe,

Provision should be made for the Employers maintenance technicians to be able to conduct thorough leak tests so joints in void spaces should be avoided.

Pipework insulation shall be closed cell nitrile rubber preformed flexible sections and shall be CFC free with a fire performance rating of Class 0. The thickness of insulation shall be to BS 5422. Where the indicated thickness in BS 5422 is not a commercial size, the nearest larger commercially available thickness shall be provided. Wrap fittings and valves with same insulation as pipework.

Include expansion joints if required to accommodate expansion and contraction. Cold bridging is to be prevented.

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

After completion, the refrigerant pipework shall be subjected to pressure and leakage testing as BS EN 378.

After installation of pipework and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested, held for 24 hours and checked for leaks, vacuumed/dehydrated and held for 12 hours (minimum).

Refrigerant charge weight shall be calculated, to the actual installed length of pipework in accordance with the manufacturer’s recommendations. The charging shall be carried out with an appropriate charging station.

Refrigerant pipework shall be adequately supported with maximum support spacing as follows:

1. Pipe nominal bore 15 to 20 (mm) - Spacing 1.0 (m)
2. Pipe nominal bore 22 to 54 (mm) - Spacing 2.0 (m)
3. Pipe nominal bore 54 to 67 (mm) - Spacing 3.0 (m)

Where the pipework cannot be adequately supported at the spacing indicated directly from the building structure, continuous proprietary channel, angle or tray support systems shall be provided. Pipework shall be supported using sheradised steel clips with a rubber or plastic sleeve to prevent chafing or vibration.

For refrigeration copper pipework 15 to 28 mm diameter support on continuous plastic coated cable tray.

The arrangement of pipework and support shall be agreed with the CA before commencement of the Works

The fixing and/or supports shall not allow any vibration to be transmitted to the structure.

All pipework shall be labeled with a reference number or other identification relating to the respective condensing unit served. Identification shall be at 3m intervals and be clearly visible.

After completion, the refrigerant pipework shall be subjected to pressure and leakage testing as BS EN 378.

After installation of pipework and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested, held for 24 hours and checked for leaks, vacuumed/dehydrated and held for 12 hours (minimum).

Refrigerant pipework shall be tested for leakage using dry nitrogen prior to connection of external units and application of pipework insulation.

Insulate entire length of pipework for thermal insulation and to avoid contact between copper and galvanising of support tray.

Electrical cables shall not be fixed to refrigerant pipework.

3201015 Copper capillary fittings

Excess flux and solder shall be removed and the joint cleaned to give a clean neat finish

3201016 Expansion of pipework

Adequate provision shall be made for expansion and contraction of all pipework, and, where possible, advantage shall be taken of pipework changes in direction to accommodate movement in pipe systems.

Anchors and guides shall be positioned to contain all movement and resist the maximum loads imposed.

Anchors and guides are to be located at points which prevent excess stresses on pipework, joints and equipment connections.

Similar provisions shall be made for building movement or building settlement.

Where natural flexing of the pipework is not practicable thermal and building movement shall be accommodated by the use of expansion joints.

Expansion joints may be of the restrained or unrestrained type and shall be provided with welded, screwed or flanged ends as appropriate and as indicated.

Expansion joint convolutions shall be of a stainless steel, super multi-ply construction fitted with stainless steel inner sleeves.

Expansion joint shall be capable of not less than 2000 complete reversals of movement at the given working conditions and the manufacturer shall be able to produce calculations to that effect.

Expansion joints shall be capable of withstanding a pressure test of twice their design pressure without loss of performance.

The manufacturer's guidelines for selection and installation shall be strictly adhered to. On completion of the installation, prior to heat being applied, the installer shall arrange for the manufacturer's representative to inspect and check that the installation of the expansion joints is in accordance with his instructions. This shall be agreed with the manufacturer prior to placing an order.

Axial unrestrained expansion joints shall only be used in positions where their pressure thrust can be contained by adequate anchor points. The installer shall arrange for the manufacturer to submit calculations for loadings on main anchors. Recommended guide spacings must be strictly adhered to.

Restrained expansion joints may be used for angular or lateral movement. Their restraints shall be capable of absorbing the full pressure thrust of the bellows, plus forces due to the connecting pipework.

Angular expansion joints shall be constructed using an ultra-low friction rocking hinge mechanism, which limits the movement to one plane. Angular expansion joints shall be used in pairs or in threes.

Lateral expansion joints shall be fitted with threaded tie bars and low friction self-lubricating hemispherical nuts allowing movement in two planes.

Stainless steel convoluted hose with a stainless steel wire braid may be used to absorb small lateral movements in pipework branches or for building movement in accordance with the manufacturer's recommendations.

Pipework subject to expansion and contraction shall be supported via swivel type hangers.

The installer shall be responsible for arranging the manufacturer to approve the expansion joints provisions prior to ordering of materials and commencement of the works.

3201017 Expansion loops

Prefabricated expansion loops shall be constructed in same pipework class and finish as the pipework system.

Where access is limited prefabricated expansion loops shall be used and only on pipework up to 65 mm.

3201018 Anchors and guides

Anchors and guides shall be provided to control the direction and effects of movement of the pipework systems and to resist stresses and loading on pipework due to forces acting on the pipework system.

The anchor loads, anchor and guide locations, method of fixing to the structure and design details shall be submitted to the CA for review prior to commencement of the works.

Ensure the structure is suitable for the transmitted stress.

Use similar or compatible materials with the pipework system.

The installer shall supply, and fix in position ready for building-in, all cleats, brackets and steelwork required for anchor points.

Steelwork secured in trenches or ducts to which anchors are attached shall be hot-dip galvanised.

Anchors attached to pipework shall be finished with two coats of aluminium paint.

Where bellows are used the manufacturer's recommendations shall be submitted for review and strictly adhered to.

Thrust blocks and suitable anchors shall be provided where pipework internal pressures are not contained by the jointing system.

Direct movement of expansion and contraction from pipe anchor points towards loops, bellows or flexible inserts. Ensure that thrust is linear relative to the axis of the pipe.

Provide a friction reducing material between adjacent metal surfaces subject to movement.

The anchor and guide components shall be of suitable size and design to withstand and transfer the pipeline thrust.

Anchors shall be as follows:

Steel pipe

On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be provided and preferably shall be welded to the pipework.

Where it is impracticable to weld the anchors to the pipework, cast-iron chairs with at least two wrought-iron stirrup bolts shall used. The bolts being provided with sufficient thread to ensure an effective grip on the pipe.

Copper pipe

The anchors shall be provided by wide copper straps secured to the pipework in such a manner that the pipe is not damaged.

PVC pipe

Use PVC coated overstraps to clamp pipework to mid steel channel section firmly attached to the building structure.

3201019 Sets and pulled bends

Sets and pulled bends shall not be allowed in:

1. galvanised pipework
2. ungalvanised tube 65 mm and above

Sets and bends shall be free from kinks and ripples and formed in a suitable bending machine.

Wherever possible the pipe shall be bent cold by the gradual application of pressure to radius of not less than 3 times the nominal bore.

3201020 Pipe sleeves and plates

All pipework passing through floors or walls shall be provided with sleeves of similar material and of such diameter as to allow free movement of pipework.

Sleeves shall be of sufficient length to finish flush with finished faces of wall or ceiling and 15mm. proud of the finished face of floors. All sleeves shall be retained in position before making good by lugs or plates welded on at sub-floor level.

The weight of pipework shall not be borne by sleeves.

Sleeves shall be manufactured from mild steel tube painted with two coats of zinc rich primer.

Copper sleeves shall be used in conjunction with uninsulated copper pipework.

Where pipework is insulated, the pipe sleeve shall be of sufficient size to allow the thermal insulation to pass between the pipe and the sleeve over its entire length.

In areas where floors are washed down install with a 50 mm protrusion above floor finish and shall have its edge rounded or bevelled. The protrusion length shall be agreed with the CA prior to installation.

Chromium plated plates shall be installed wherever pipes pass through walls, floors and ceilings exposed to view. Samples shall be submitted to the CA for approval prior to installation.

3201021 Pipe sleeves through fire barriers

Sleeves which are contained in walls, ceilings or floors which are fire barriers shall be additionally packed with a non-combustible material for the entire length to form a fire/smoke stop of the required fire rating.

The material shall be subject to approval and must comply with Building Control and the Building Regulations.

Petroleum based expanding foam products shall not be used.

The ends of sleeves packed with material shall have suitable fire resistant mastic applied to seal the fibres and present a neat appearance.

Sleeves for UPVC pipes shall contain an in tumescent material to BS 476.

3201022 Pipe sleeves through acoustic barriers, enclosures and plantrooms

Sleeves on pipes which are contained in walls, ceilings or floors which are acoustic barriers, or through acoustic enclosures, or plantroom walls, floors or ceilings, shall be packed with a 12 mm thick resilient neoprene inner sleeve around the pipe and filled with a non-setting mastic compound. The outer edges of the sleeve shall be made air-tight by sealing with a dense non-setting mastic compound. Where such barriers are also fire barriers the material shall comply with Building Control and the Building Regulations.

3201023 Pipe supports

Pipework supports are to be arranged so that no undue stress is imposed upon the pipes.

Ensure that all materials used for pipework supports are compatible with the pipeline materials.

Pipework supports shall not exceed the maximum intervals stated elsewhere.

Additional supports shall be provided for equipment such as valves, strainers and ancillaries so that minimum stress is imposed on the pipework and the weight is not taken by the pipework. The support arrangement shall allow safe operation and removal of the component.

All brackets and supports shall allow free movement of the pipes due to expansion and contraction with special regard to prevention of damage to any thermal insulation and vapour barrier.

Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring the closest spacing with adequate provision for the unequal movement due to expansion and contraction. Supports shall also be provided at bends where there is a run of pipework 1 metre or more both sides of the bend.

Cantilever type supports from walls will not be allowed except for single pipes of diameters up to 50 mm.

Obtain approval for all fixings to structural concrete or structural steelwork and loads imposed on the structure. Shot fired fixings shall not be used or any reinforcement drilled through.

Static point loadings transferred to the structure which cannot be accommodated by the structural fixings shall be spread over a larger area by means of additional brackets and/or additional load spreading primary steelwork.

The installer will be responsible for marking out the exact positions where pipe brackets are to be built in and for checking the accuracy, levels and alignment of supports after building in by others.

For vertical support spacing check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable flexible couplings. Ensure adequate support when using non-end load capable flexible couplings.

Steel pipework maximum support spacing

Pipe bore Nominal (mm)	Maximum support spacing (m)		
	horizontal		vertical
	bare	insulated	Bare or insulated
up to 15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.6
50	3.0	2.4	3.6
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	3.7	3.0	4.6
125	3.7	3.0	5.4
150	4.5	4.5	5.4
200	5.0	5.0	6.0
250	5.0	5.0	6.0
300	6.1	6.1	9.0
350	9.5	7.0	9.0
400	9.5	7.5	9.5
450	10.0	8.0	10.0
500	11.0	9.0	11.0

Copper pipework maximum support spacing

Pipe bore Nominal (mm)	Maximum support spacing (m)		
	horizontal		vertical
	bare	insulated	bare or insulated
up to 15	1.2	1.2	1.8
22	1.2	1.2	2.1
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0

54	2.7	1.8	3.0
67	3.0	2.4	3.5
76	3.0	2.4	3.5
108	3.0	2.4	3.5
133	3.0	3.0	3.5
159	3.5	3.5	3.5

Cast iron pipework maximum support spacing

Pipe bore Nominal (mm)	Maximum support spacing (m)		
	horizontal		vertical
	bare	insulated	bare or insulated
All sizes	1.8	1.8	3.0

At least one fixing shall be provided for each unit length.

UPVC and polyethylene pipework maximum support spacing

Pipe bore Nominal (mm)	Maximum support spacing (m)	
	horizontal	vertical
32 – 40	0.5	1.2
50	0.6	1.2
75 - 100	0.9	1.8
150	1.2	1.8

Polyethylene pipework

Pipe bore Nominal (mm)	Maximum support spacing (m)	
	horizontal	vertical
up to 15	0.5	
20	0,55	
25		
32 – 40	0.5	1.2
50	0.7	1.2

For plastic pipework space vertical support intervals at no greater than 1.5 times the horizontal spacing.

For UPVC and ABS pipework reduce spacing between supports for operating temperatures above 20 °C in accordance with manufacturers' recommendations. Support continuously for operating temperatures above 60 °C.

3201024 Pipework brackets

Where expansion takes place in pipework, pipes shall be supported on cast iron roller chair assemblies with retaining strap or 'U' bolts to restrain transverse movement.

Where expansion is minimal pipework shall be held in position by 'U' bolts, split bands or split pipe rings. Single pipe supports from walls shall be held in position by two piece screw-on clips which shall be removable without disturbing the fixings. Caliper, single piece rings, or 'snap on' type brackets will not be allowed.

Brackets shall be manufactured from the following materials:

Steel and cast iron pipework
Mild steel or malleable iron, with cast iron rollers, mild steel nuts, bolts and washers and mild steel screws.

Copper pipework

Brass or gun metal with cast iron rollers plastic coated, and brass screws, nuts, bolts and washers. Alternatively mild steel plastic coated pipe brackets may be used on larger diameter pipework.

Plastic pipework
PVC coated steel for 75 and 110 mm diameter plastic pipework and plastic or polypropylene for smaller diameter pipes. Fixing screws, nuts and bolts shall be steel with a galvanised or sheradized finish.

3201025 Venting and draining

All pipework shall be laid to falls to suit the pipework material and its diameter.

Equipment shall be provided with drains and vents which shall be accessible from outside the casing.

Adequate drains and vents shall be provided to facilitate draining and venting the pipework system.

Drain points shall be located in accessible positions and shall include drain cocks with hose union and removable key. 'Y' type drain cocks shall not be used.

Where pipework sections can be isolated, drain and vent points shall be provided to facilitate draining down and venting of that section of pipework.

Drain points on medium and high temperature pipework shall be fitted with a flanged valve and blank flange.

In plantrooms a 30 m length of 25 mm flexible rubber/armoured hose pipe shall be provided and fixed to a wall. The hose shall have a connection to match the drain valves.

The installer shall allow for the provision of fast fill and drain connections in accordance with the water treatment specialists' requirements and also in accordance with the current COP relating to water treatment and cleaning.

De-aerators shall be installed on all primary and secondary hydraulic circuits.

3201026 Air bottles

On pipework up to and including 80 mm size, each bottle shall be manufactured from 50 mm size tube 300mm long with a screwed or brazed cap. Air bottles on pipework up to 100 mm size and over shall be manufactured from 100 mm size tube, each 380 mm long. Bottles shall be manufactured from galvanised steel tube on ferrous pipework or copper tube on non-ferrous pipework systems.

All air bottles shall be complete with a 10 mm gun metal key operated, needle seated air cock.

Where the air cock is at high level or inaccessible from floor level a 15 mm size a steel or copper extension tube shall be provided to a position approved by the CA within 1.5 m of the floor and fitted with a 10 mm size needle-seated globe valve or air cock.

Automatic air eliminators shall be provided where air bottles are not practicable to install or at locations approved by the CA.

3201027 Automatic air vents

Shall be 15 mm and have a bronze body, copper or stainless steel float and guides, non-corrodible needle valve and seats and be suitable for the system temperature and pressure.

Each automatic air vent shall be complete with a lock-shield valve.

The discharge pipe from the automatic air vent shall be manufactured in copper tube and shall be run to discharge over the nearest gully, tundish or other suitable location to the approval of the CA.

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

3201028 Dirt pockets

Full-bore dirt pockets shall be provided at the bottom of all vertical pipework risers and valved to allow pockets to be drained without draining the system.

The dirt pockets shall be formed from 300mm. length of similar full bore pipework beyond the last branch and/or connection complete with isolating valve and drain cock.

The isolating valve shall be line size up to a maximum of 50 mm.

3201029 Overflows and condensate drains

Equipment which has a continuous or intermittent discharge of waste water shall have an overflow/drain connection and discharge pipe which shall fall continuously to the nearest gully.

Overflow/drains shall be the same diameter as the connection size to the equipment and increased as soon as possible to 25 mm.

A 150 mm diameter by 150 mm high tundish shall be provided adjacent to the equipment into which the overflow/drain shall discharge.

On connections to coils/cooling towers a waste trap shall be installed between the coil/cooling tower and the drain.

Where more than on overflow/drain runs into a common pipework drain the diameter of the pipework shall be sized, by the installer, to ensure that the system drains to the gully at all times.

An air break trap shall be provided to each drain to comply with CIBSE TM 13.

Glass traps or clear plastic traps shall be provided for air handling unit drain trays

Glass traps shall be used in all healthcare and clean room applications.

3201030 Fan coil connections

Where indicated flexible hose fan coil connections shall be provided unless stated otherwise.

Fan coil connections shall consist of an EPDM inner liner with a stainless steel wire braid. The fittings shall be nickel plated brass with stainless steel ferrules.

Hoses shall have an overall length of not less than 300mm. and resist kinking when bent through 180 degrees and shall be designed for a working pressure of 20 bar and a temperature of 110 C.

The hoses shall be colour coded red and blue to indicate its suitability for hot or chilled water.

Chilled water connections shall be fully insulated and the insulation fitted with end caps.

3201031 Flushing bypasses

Provision shall be made for temporary flexible or fixed permanent full-bore by-passes to be fitted across all major items of plant in order to facilitate the circulation of water during dynamic flushing operations.

Items which could be damaged by the flushing and cleaning process shall be isolated and cleaned by approved alternative methods.

3201032 Positioning of control components

Pipeline control components shall be installed in accordance with the manufacturer's recommendations and in the positions indicated on the drawings or stated elsewhere in this specification.

For control components incorporated in insulated pipework submit to the CA for approval details of insulation methods proposed.

Supports shall be provided to ensure no strain is imposed on the components.

The components shall be installed so as to ensure adequate and safe access for operation and maintenance.

3201033 Press-fit pipework systems

General
The use and extent of press-fit pipework systems shall be as indicated elsewhere including the limitations of pipe sizes.

Press-fit systems shall not be used for natural gas or other gas systems.

Pipework
Pipes shall adhere to the required specification of the press-fit system manufacturer.

Carbon steel (OD 12 to 54 mm) to DIN 2394. The pipe shall be manufactured from unalloyed high purity low carbon steel. The outside of the pipe shall be primed and protected with a 1mm thick polypropylene coating.

Stainless steel (NB 65 to 100 mm for heating only) tube manufactured from Cr-Ni \steel material No 1.4301 to DIN EN 10088/BS 304

Copper tube to BS EN 1057:2006+A1:2010 - R250/R290

Stainless steel tube manufactured from Cr-Ni-Mo Steel material No 1.4401 to DIN EN 10088/BS 316 and conforming to DVGW W541.

Pipes shall be supplied with plastic end caps to prevent ingress of dirt and stored in dry conditions prior to installation.

Fittings
System operating temperatures and pressures shall be commensurate with the seal ring material. Maximum operating pressure shall be 16 Bar and working temperatures of -20°C to 110°C. Prior to commencement of the installation, the contractor shall confirm that the pipework system chosen is capable of handling the design temperatures and pressures.

Purpose-made press-fit jointing fittings shall incorporate factory-fitted butyl rubber seal rings within a circumferential profile.

The joint shall be accomplished by use of a jawed circumferential crimping tool or a similar tool utilizing press slings.

Pipe fittings shall be primed and painted matt white to match the factory finished plastic coated tubes. In areas of high humidity and where moisture will contact the surface of a

fitting, a layer of anti-corrosion tape shall be applied after priming and prior to the application of the insulation.

Installation

Where the use of press-fit type pipework system is selected, the whole of the pipework system shall be installed with a single manufacturers' range. The installer shall not use more than one press-fit manufacturer on a pipework system. Press-fit capillary and compression type fittings shall not be used on the same system.

Pipe for press-fit jointing shall be prepared fully in accordance with the published instructions of the jointing system manufacturer including the neat removal of any plastics coatings to pipes.

Pipe and jointing fittings within a system shall be fully compatible. A complete system shall be of one manufacturer's supply only.

Operatives shall be fully trained by the proposed manufacturer in the use and installation of its proposed products.

Submit to the CA prior to the commencement of the Works documentary evidence that operatives have undertaken such training by the joint system manufacturer.

The installer shall implement a suitable methodology and recording procedure to enable the craftsman or workman responsible for any work to be identified including the joints made by each operative and the sequence in which they were made. The methodology and recording procedure shall be agreed with the CA prior to commencement of the installation.

Procedures shall be adopted to ensure that all joints are successfully made and fluid-tight before systems are filled and pressure-tested. Documentation shall be available for inspection by the CA.

The contractor shall mark the end of each tube prior to crimping the joint to ensure and demonstrate that the pipework was fully inserted into the fitting when made.

The contractor shall consider the routing of pipework and in particular the location of joints with regard to the health and safety risk a joint failure could present.

Account shall be taken of the overall dimensions of fittings in order to achieve neat and economic installations.

Pipes shall be cut square and true using tube cutters. Pipe ends must be de-burred internally and externally, prior to insertion with fittings.

No oils shall be used for lubrication of pipe cutting or fitting insertion.

Only press-fit tools which will not operate with an incorrectly set-up joint and/or inadequate power supply, and will not disengage until the joint is completed, shall be used.

Tools shall be regularly cleaned and otherwise maintained to the manufacturers' published instructions.

Bending tools must be approved by the pipe manufacturer. No heat shall be directly applied to the pipe for bending purposes.

All changes in direction < 35mm diameter shall be achieved by the use of press-fittings

Bending radii for pipes shall be in accordance with the recommendations of the pipe manufacturer.

Pipe supports shall comply with the requirements of the manufacturer.

Connections to equipment items shall be by threaded or flanged press-fit conversion fittings.

Press-fit joints shall not be made within 300mm of brazed or welded joints.

All systems shall be leak tested on completion.

Water treatment regimes shall be to the approval of the manufacturer of the tube/fittings.

All metallic pipework systems shall be earth bonded to comply with the requirements of the current edition of BS 7671.

Testing and inspection of press fit joints

Checking of each operatives work shall be carried out by the operative's supervisor on a random basis and the results recorded for review at progress meetings. Non-destructive checking shall be undertaken on approximately 10% of all joints. Non-destructive checking shall be evenly distributed over the whole of the Works and shall be evenly split between all operatives employed on the Works.

Should any joint fail then a further 15 joints by that operative shall be immediately checked.

Should any of the second batch of joints fail then the CA shall have the right to instruct the cutting out and replacement of all joints and the replacement of all responsible operatives previously employed on site at no additional cost. The installer shall take all necessary measures, subject to agreement with the CA, in order that subsequent jointing shall be in compliance with the required standards.

3201034 Victaulic Standard Grooved Piping System for Carbon Steel up to 300mm Diameter

General

The use and extent of Victaulic pipework systems shall be as indicated elsewhere including the limitations of pipe sizes.

To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilised shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.

Operatives shall be fully trained by the manufacturer in the use and installation of its proposed products including grooving tools, application of groove, and product installation.

Submit to the CA prior to the commencement of the Works documentary evidence that operatives have undertaken such training by the joint system manufacturer.

Allow for a visit from a Victaulic representative to visit site to review the installation, when not more than 10% of the installation has been completed. The Contractor shall remove/replace any in properly installed products at no expense to the contract.

Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified, see later clauses.

Couplings installation shall be complete when visual metal-to-metal contact is reached.

Pipework

Pipework to be carbon steel EN 10255, EN 10216, EN 10217 and EN 10224.

Pipework to have roll or cut grooved ends as appropriate to the pipe material, wall thicknesses, pressures, sizes and method of joining.

Couplings for joining steel pipe
Couplings will be suitable for pipe sizes from 20mm to 300mm. The couplings will be manufactured in two segments of cast ductile iron, grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, flexible type. Gaskets used for potable water applications shall be WRAS listed for potable water service.

Mechanical coupling bolts shall be zinc plated, heat treated carbon steel track head with a minimum tensile strength 758,450k Pa.

Coupling housings shall be provided for support and hanging in accordance with CIBSE guidelines.

Couplings 20mm to 40mm, Victaulic style 77, standard flexible coupling. Gasket shall be grade 'E' EPDM compound with green colour code, operating temperature -34°C to +110°C.

Couplings 50mm to 200mm, Victaulic style 177. Gasket shall be grade 'EHP' EPDM compound with red colour code, operating temperatures -34°C to +110°C.

Couplings 250mm to 300mm, Vitaulic styple 77, standard flexible coupling. Gasket shall be grade 'E' EPDM compound with green colour, operating temperatures -34°C to 110°C.

The gaskets shall be synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers designated in EN BS 681.

End fittings
Standard end fittings shall be ductile iron conforming to Grade 65-45-12, forged steel with 9.53 mm wall thickness.

Hole cut branch outlets
Pipe size 15mm to 20mm. Strapless outlets to be Victaulic style 923.

Pipe sizes 50mm to 200mm. Bolted branch outlets shall be manufactured from ductile iron, grade 65-45-12 with synthetic rubber gasket and heat treated carbon steel zinc plated bolts and nuts. Victaulic style 920/920N.

Flange adapters
Flange adapters shall be suitable for use with grooved end pipe and fittings, flat faced for mating to EN BS 1092 PN 10/16, Victaulic style 741.

Tools
Any tools used shall be manufactured and supplied by Victaulic. Rolled sets or cut groovers shall be compatible with the pipe material and wall thickness.

Fittings
Valves, strainers etc shall be as detailed within this specification, suitably flanged for incorporation into the pipework system.

3202000 VALVES AND PIPEWORK ANCILLARIES

3202001 General requirements

Valves, cocks, air vents and pipework accessories shall be provided where indicated on the drawings and at all positions necessary for the proper working, regulation, control and maintenance of the installation with the approval of the CA.

All valves, cocks, vents and accessories installed in the Works shall be approved by the CA prior to ordering. Valves shall be as far as it is practicable of the same manufacture and style to provide conformity and to simplify maintenance. In addition they shall comply with the requirements of the Local Water Board.

Ensure that valves and cocks are pressure tested at the manufacturer's works, in accordance with appropriate British Standards specification.

All valves required to comply with the Pressure Systems Safety Regulations shall carry the CE mark and have a declaration of conformity.

All valves, cocks, vents and accessories must be fitted in such a manner that they are accessible for operation and maintenance. Valve operating handles must be easily accessible and operation must not be impeded by structure or other services.

Seals, discs, gland packing, plug lubricants etc. shall be suitable for the application and operating conditions.

Where available, BSI kite marked valves shall be supplied.

Only Water Research Council approved valves shall be used for potable mains, hot water service and cold water services.

Institution of Gas Engineers (IGE) certified valves shall be used on gas service.

The pressure rating of valves must equal or exceed system working pressures at the relevant temperature and the system test pressure.

The installer is responsible for ensuring that all balancing and flow regulation valves are correctly selected and installed to suit the flow rates indicated. All regulating/balancing valves must be approved by the CA prior to installation.

Valves shall be provided on all pipework wherever necessary to achieve proper isolation and regulation of the whole systems. They shall be installed to isolate and balance every section of the pipework network including but not limited to the following locations:-

1. To isolate each item of equipment including heat transfer terminal units
2. To regulate and balance the flow through each item of equipment including heat transfer terminal units, and control valves
3. To isolate every section of the pipework network including sub-branch mains, sub-circuits and to multi-connections to heat transfer terminal units
4. To regulate and balance the flow through every section of the pipework network including sub-branch mains, sub-circuits, and to multi-connections to heat transfer terminal units
5. To isolate, regulate and balance the flow to any item of equipment supplied by or, to be connected to the systems, by others (Should the equipment or plant not be connected up prior to balancing, temporary by-pass connections and a regulating valve shall be installed to achieve balancing)
6. To isolate, and allow the removal of all control valves, flow meters, strainers, and other similar pipeline ancillaries
7. To isolate, regulate and balance the whole, the sub-branch and the sub-circuit on hot water services flow and return systems
8. To isolate each float operated valve
9. To isolate water services to individual items of sanitary equipment, ranges of kitchen equipment, ranges of sanitary fittings and individual water draw-off fittings

10. To isolate immediately inside the building incoming utility services

Stopcocks may be used for isolation within buildings on all mains or pressurised water services and in addition on tank fed services on pipework up to 22 mm diameter only. Above 22 mm diameter gate type isolating valves only shall be used.

Regulation and balancing of the systems shall be achieved by the installation of commissioning stations and isolating valves. For variable flow circuits DPCVs and IDDVs shall be provided complete with isolating valves.

A commissioning station shall be provided on the return branch or sub-circuit return main and an isolating valve shall be provided on the corresponding flow connection, flow branch or sub-circuit flow main. The commissioning station shall consist of a double regulating valve and orifice plate as detailed elsewhere.

The commissioning stations shall be installed to the manufacturer's recommendations, with special regard to straight pipe lengths required before and after the assembly.

A regulating valve shall be provided on the return pipe from each terminal unit and an isolating valve shall be provided on the corresponding flow connection to each terminal unit. Where DPCVs and IDDVs are used, measuring stations shall be provided upstream of the isolation valve.

Access to double regulating valves must be such that scales and verniers are clearly visible.

At least 100 mm clearance from pressure test points must be allowed to enable manometer tubes to be connected without kinking. Ensure test points are located to enable safe, positive quick–coupling and uncoupling of the flexible connections.

Large valves shall not be supported by the pipework to which they are supported and additional supports positioned close to each side of the valve shall be provided. Removal of the valve shall not allow the adjacent pipework to sag.

Check valves shall be installed where plant operates on an automatic changeover basis or where flow reversal can occur. Check valves shall be installed in accordance with the manufacturer's recommendations.

Air vents shall consist of either open air pipes to atmosphere manually operated air cocks or automatic air release valves.

Open air vent pipes shall not be less than 20mm diameter continued up beyond the highest point of the system and turned to discharge over the feed and expansion tank. All open vents shall run with a continuous rise from the point of connection to the system, to the point of discharge.

Where indicated, valves or cocks shall be lockable, with purpose-made locking devices which do not impede the fast closure of the valve where that is necessary. The locking device shall remain attached to the valve in both open and closed position.

Where modifications or extensions to existing services are to be undertaken, all valves which are to be removed and re-fixed shall be overhauled thoroughly, with glands and seals renewed, all to the satisfaction of the CA.

All valves shall be constructed from asbestos free materials.

3202002 Provision of lockshields on valves

Where valves are shown as lockshield pattern or where the accidental closure or opening of a valve from its normal functioning position could cause harm to equipment or persons, then the valve shall be of the lockshield type with a bronze, chromium plated, or cast iron shield and complete with a loose key. In all other respects the valve shall be as specified for wheel type valves but of the lockshield type.

3202003 Pipeline strainers

Strainers shall be provided on the inlet connections to all pumps, meters, pressure reducing valves and where stated elsewhere or shown on the drawings to safe guard against dirt and other foreign particles.
They shall be of the 'Y' type up to 150 mm and pot or "Y" type on 200 mm and above as indicated elsewhere and shall be located between isolating valves with a convenient drain adjacent and installed in such a way that the strainer element/basket can be readily removable below the level of the body.

Strainers shall be the same size as the pipeline immediately before any reduction in size of pipeline to suit a control valve or pump/plant connection.

Strainer elements shall be cleaned and free from dirt prior to practical completion.

Provide plugged connections for drain, air vent and differential pressure monitoring located in the adjacent pipework or within the strainer body. Threads shall be to BS 21 and BS EN 10226-1.

Provide pressure gauges on the inlet and outlet of each strainer on sizes 32 mm and above unless stated otherwise.

Strainers over 100 mm shall be complete with an adequate size of blow-down connection and drain cock and shall have a discharge pipe which shall run to the nearest gully.

Unless otherwise stated strainers shall have a stainless steel element with perforation size as indicated below. Screen free flow area shall be not less than 250% of the pipe bore.

Screen perforations:

Nominal pipe size	Screen perforations
15 mm to 50mm	Within range 0.7 – 0.9 mm diameter
65 mm and over	Within range 1.5 – 1.8 mm diameter

The installer shall submit to the CA for approval details of all strainer elements prior to ordering.

Baskets shall be capable of withstanding the maximum pressures without distortion.

Strainers shall be complete with an asbestos free non-stick gasket.

Strainer bodies up to 50 mm shall be bronze to with compression ends to BS EN 1254-2.

Strainer bodies above 50 mm shall be cast iron with flanged ends to BS EN 1092-2.

3202004 Radiator Valves

Valves shall be in accordance with BS 2767

The valves shall be bronze angle or gate pattern as determined by the radiator connections and as indicated.

Connections shall be of the type to suit the pipework into which they are installed and shall have male union screwed connections to the appliance. Connections shall be threaded to BS 10226-1 or compression to BS EN 1254-2 to suit pipework as indicated.

Angle patterns shall have spherical brass discs, free to rotate on stem and gate patterns shall have solid bronze wedge disc. Both patterns shall be complete with non-rising stem, hand wheel or lockshield manufactured from white moulded polycarbonate, bronze screw in bonnet and screwed gland and one piece moulded packing. Valves shall be suitable for operating pressures and temperatures on systems up to 1000 kPa at 120°C

The valve finish shall be to match the respective thermostatic valve or as otherwise stated and shall be approved by the CA prior to ordering.

The valves shall have hand-wheels on the radiator flow connections and lockshield type on the return unless otherwise specified.

3202005 Thermostatic Radiator valves

The radiators shall have on the flow connection a thermostatic radiator valve to BS EN 215 and installed to the manufacturer's recommendations.

Valves shall be straight or angle pattern to suit the application and as indicated.

Where thermostatic valves are used, the return valve from the radiator shall be of the lock shield type with the same body finish as the thermostatic valve unless otherwise indicated.

The valves shall be complete with integral sensor unless stated otherwise and suitable for locking at any temperature setting in its range and complete with frost protection facility.

Valve connections shall be of the type to suit the pipework into which they are being installed, and shall have male union screwed connections to the appliance.

The finish of the valves shall be either polished brass or chromium plate or as stated otherwise and approved by the CA prior to ordering.

Where installations are fitted with thermostatic radiator valves, the sensing heads must not be fitted until commissioning has been completed, witnessed and approved by the CA.

3202006 Safety and relief valves

Safety to discharge with rapid opening action to prevent pre-determined safe pressure being exceeded. Relief to discharge with opening action proportional to increase in pressure above set pressure.

Safety and relief valves shall meet the requirements of the appropriate British Standard for the equipment to which they are connected, and be suitable for the operating conditions of the system. Valves shall be sized for the rated output of the appliance.

Direct acting safety valves shall be in accordance with BS EN 4126-1.

Pipework connections shall be fitted, where indicated, to provide discharge connection to safety and relief valves. Discharge and waste pipes shall terminate at visible and safe positions to be agreed with the CA. Connections to drains shall be provided as indicated.

Safety and discharge pipework for hot water systems shall be laid with a continuous downward gradient.

Spring type safety valves

Valves shall be of the enclosed spring loaded high lift type.

Valves up to 50mm nominal diameter shall be bronze or DZR copper alloy body as indicated and threaded to BS 21 and BS EN 10226-1.

Cast iron valves shall be flanged to BS EN 1092-2.

They shall have a screwed on or bolted on spring casing, carbon steel spring and a gun metal valve head, seat and adjustable screws and ferrule.

Valves shall be complete with a screwed on top cover, testing lever and padlock and shall have a discharge pipe of the same diameter as the valve which shall terminate 300 mm from the floor level.

The valve release pressure shall be set at a pressure above the system operating pressure and as agreed with the CA. The spring range shall be selected to give equal adjustment either side of the operating pressure.

Valves shall be stamped with their set pressure and limiting temperature.

3202007 Isolating valves (LTHW, CHW, Condenser water)

Ball Valves 15 mm up to 50mm
Type: Ball valve
Body material: Bronze or DZR brass (corrosion resistant)
Pressure rating: PN25
End connections: Threaded to BS EN 10226-1
Specification: PTFE seat and packing
DZR brass ball
Mild steel (zinc plated) with PVC covered lever WRAS listed and BS kitemark approved.
Temperature range: -10°C to 100°C
Operation: Lever operated, quarter turn, tight shut-off

Operation of the valve shall generally be by lever fitted with stop permitting a 90° movement of the ball between fully open and closed position. In areas where space is limited a T-handle shall be fitted. Valves on insulated pipework shall be provided with an extended stem in which the lever is held above the pipe insulation.

As indicated, valve spindles shall be suitable for operation by a screwdriver where the valve is liable to unauthorised use or lever operation

Gate valve 65mm and above
Type: Gate valve to BS EN 1171
Body material: Cast iron
Pressure rating: PN6
End connections: Flanged to BS EN 1092-2
Specification: Wedge disk
Non-rising stem of manganese bronze
Inside screw
Bronze disc
Malleable iron hand-wheel
BSI kite mark approved
Operation: Hand-wheel

Butterfly valve 65 mm and above
Type: Butterfly to BS EN 593
Body material: Cast iron
Pressure rating: PN16
Specification: Short wafer lugged type
WRAS approved EPDM liner
Stainless steel shaft and disc
WRAS approved
Operation: Lever operated up to 150 mm.
Valves 150 mm and above shall be complete with gear unit.

Valves shall have a pressure rating to suit the maximum operating pressure of the system.

Valves shall be suitable for fitting between flanges complying with BS EN 1092, centrally located by fully lugged fixing bolts.

3202008 Valves for flow regulation

Valves shall be selected to produce the required pressure drop at between 50% and 75% of the fully open position.

Double regulating valve up to and including 50mm
Type: Double regulating valve to BS 7350

Body material: Bronze
Pressure rating: PN20
Temperature range: -10°C to 100°C
End connections: Threaded to BS 21 and BS EN 10226-1
Specification: Oblique or Y pattern
WRAS approved

Valves shall be of the screwed end pattern and shall be complete with position indicator and lockable adjustable setting position.

Where necessary, valves shall be selected for low flow conditions.

65mm and above
Type: Double regulating valve to BS 7350
Body material: Cast iron
Pressure rating: PN16
Temperature range: -10°C to 120°C
End connections: Flanged to BS EN 1092-2
Specification: Oblique or Y pattern
Rising stem
Bolted on bonnet
Screwed boss into which an in-built drain cock/valve or air vent can be provided
Hand-wheel material: Cast iron

3202009 Check valves

All valves shall have flow direction indicators and shall have a pressure rating to suit the maximum operating pressure of the system. Where used on systems with operating temperatures in excess of 65°C the disk and seating shall be suitable for the conditions.

Non-return valves shall be of the straight pattern, swing check type. Check valves shall be installed in horizontal pipework unless they are specifically selected for operation in vertical pipework. They shall be selected to present a low resistance to flow.

Up to and including 50mm
Type: Swing type check valve to BS 5154 and BS EN 12288
Body material: Bronze
Pressure rating: PN16
Temperature range: -10 to 100°C
End connections: BS21 taper
Specification: Metal disc; screwed in cap; BSI Kitemark; WRAS listed.

65mm and above
Type: Swing pattern check valve to BS EN 12334
Body material: Cast iron
Pressure rating: PN16
Temperature range: -10 to 220°C
End connections: Flanged BS EN 1092-2
Specification: Cast iron disc; fibrous gasket.

Valves for pipes of 200 mm diameter and larger shall be wafer pattern, manufactured from cast iron or cast steel, with a stainless steel stem and disc and EPDM or reinforced PTFE seat and shall be suitable for installation between flanges. Wafer check valves shall be correctly aligned to achieve efficient valve operation with minimum head-loss, and prevent the valve disk fouling downstream piping.

3202010 Commissioning sets

The installer shall be responsible for the final selection of all commissioning sets.

Commissioning sets shall comprise metering stations and double regulating valves installed in the positions for the proportional balancing of heating and chilled water pipework systems.

The metering station shall be fitted to the upstream valve connection in accordance with the manufacturer's recommendations.

The installer shall submit to the CA, prior to ordering, a comprehensive schedule, prepared by the manufacturer, detailing the correct selection of each commissioning set in respect to signal pressure and valve position.

Flow measurement devices must always be sized using pressure differential – flow rate criteria and the general assumption that line size devices will suffice will not be acceptable.

Double regulating valves shall be selected to ensure that the required head absorption occurs at valve settings not less than 25% open.

Flow measurement devices should be selected and sized to meet the following requirements at the design flow rate:

The minimum pressure differential signal should not be less than 1kPa
The minimum head loss across the device should be consistent with the minimum pressure differential signal requirements

With water flow rates of 0.04 l/s or less, low flow measurement units shall be used.

The accuracy of the flow rate derived from the pressure differential across the signal generating device shall be within ± 5%.

Where orifice valves are specified, these shall be used in their fully open position to ensure minimum pressure drop across the valve and the valve must provide positive shut-off.

Commissioning sets shall be fitted in a straight length pipe run. The installer shall be responsible for obtaining from the flow measurement device manufacturer the appropriate number of pipe diameters to be allowed upstream and downstream of the device. Typical values are 10 pipe diameters downstream and 5 diameter upstream of any change in pipe direction to minimise the effect of turbulence on the pressure signals at the measuring device. Flow charts allowing the manometer readings to be converted into flow rates shall be provided for each size of measuring station.

The installer shall take due care throughout the installation and during the flushing and cleaning process to ensure that the flow measurement devices remain clean and undamaged.

Ensure that test points are not installed so as to become dirt traps. Where practical, high pressure test points shall point upwards to allow ease of venting.

Up to 50mm
Single unit commissioning valve with combined functions of regulation and flow measurement

Type:	Fixed orifice double regulating valve to BS 7350
Valve body material:	Bronze
Pressure rating:	PN25
Temperature range:	-10 to 100°C
End connections:	Threaded to BS 21
Specification:	Fitted with two insertion points allowing quick connection; WRAS approved; integral orifice plate

For water flow rates of 0.04 l/s or less, low flow measurement units shall be used

65mm and above

Shall consist of a flanged oblique pattern double regulating valve complete with cast iron metering station installed on the return side of any circuit or sub-circuit

Type:	Fixed orifice double regulating valve and close coupled fixed orifice fitting manufactured to BS 7350
Valve body material:	Cast iron
Orifice plate:	Stainless steel orifice plate with two stainless steel extension tubes fitted with insertion test points
Pressure rating:	PN16
Temperature range:	-10 to 100°C
End connections:	Flanged BS EN 1092-2
Specification:	Cast iron disc; cast iron bonnet;
Hand-wheel material:	Cast iron

Independent means shall be provided for positive isolation on pressure tappings.

Flow measuring device 15mm up to 65mm

Type:	Flow measuring device
Valve body material:	Bronze
Pressure rating:	PN25
Temperature range:	-10 to 100°C
Specification:	Fitted with two insertion points allowing quick connection; WRAS approved; integral orifice plate; flow measurement accuracy ± 3%

3202011 Automatic balancing valves

15 mm to 50 mm

Automatic balancing valves shall have replaceable cartridges with flow rates determined at the factory which shall be maintained within ±5%.

The flow cartridge shall be stainless steel or nickel finish and each cartridge shall be coded to indicate flow rate duty.

The cartridge shall be removable from the body to provide access for change, inspection and cleaning without removing the body from the pipeline.

The valve shall be complete with two colour coded pressure tapping ports. Independent means shall be provided for positive isolation on pressure tappings.

If the unit is not isolated during system flushing the flow cartridge shall not be fitted and a blank flushing cap installed.

The stem and test points shall be provided with extension pieces to allow for insulation.

Body material:	DZR copper alloy
Maximum Pressure:	25 bar
End connections:	Threaded to BS 21

3202012 Isolating valves (portable water, hot and cold water services)

15 mm to 22 mm (Ball valve type)

Where stated elsewhere or on the drawings, isolating valves to appliances shall be of the ball valve type.

Type:	Ball type valve
Body material:	Bronze or DZR copper alloy body (chrome finish unless stated otherwise)
Pressure rating:	Suitable for working pressures up to 16 bar
End connections:	Threaded to BS 21 or compression to BS EN 1254 as applicable

Specification:	Chrome or nickel plated DZR sphere with full bore aperture; PTFE seats and stem seals; shall be fitted with internal stop permitting a 90° movement of the ball between fully open and closed position; anti-blow out stem; WRAS approved;
Operation:	Screw driver operated or key operated

15 mm to 50 mm (Ball valve type)

Type:	Ball type valve
Body material:	DZR copper alloy / DZR brass
Pressure rating:	PN25
End connections:	Threaded to BS 21
Specification:	Quarter turn; tight shut-off; chrome plated DZR copper alloy or brass sphere with full bore aperture; PTFE seats and stem seal; anti-blow out stem; WRAS approved;
Operation:	Lever operated (in areas where space is limited a T- handle shall be fitted)

Valves on insulated pipework shall be provided with an extended stem in which the lever is held above the pipeline insulation.

65 mm to 300 mm (Gate valves)

Type:	Gate valve to BS EN 1171
Body material:	Cast iron
Pressure rating:	PN16
End connections:	Flanged to BS EN 1092-2
Specification:	Wedge disk; non-rising stem; inside screw; cast or malleable iron hand-wheel; BSI Kitemark
Operation:	Hand-wheel operated

65 mm and above (Butterfly valves)

Type:	Butterfly valve to BS EN 593
Body material:	Cast iron
Pressure rating:	PN16
Specification:	Lugged type; WRAS approved EPDM liner;stainless steel shaft;stainless steel disc; WRAS approved; lever and gear operated valves to be complete with long body neck for lagging clearance; good control characteristics.
Operation:	Lever operated up to 100 mm. Valves 150 mm and above shall be complete with gear unit.

3202013 Check valves (Portable water, hot and cold water services)

Check valves shall permit flow in one direction only and close automatically if flow reverses.

15 mm to 50 mm

Type:	Swing type check valve to BS 5154 and BS EN 12288
Body material:	Gunmetal or bronze
Pressure rating:	PN 16 Series B
End connections:	Threaded to BS 21
Specification:	Metal disk; screwed in cap; metal to metal seat; WRAS approved; BSI Kitemark; flow direction indication.

Valves shall be suitable for mounting in horizontal and vertical pipe (with vertical flow upwards).

Where specified elsewhere the disc material shall be nitrile rubber but restricted to 90 °C maximum temperature and WRAS approved.

3202014 Double check valves (Hot and cold water services)

Double check valves where indicated for the purpose of prevention of water contamination by back-siphonage, backflow or cross connection, shall be to BS EN 13959 and be WRAS approved.

The body material shall be bronze or DZR copper alloy with compression connections to BS EN 1254-2 or threaded to BS 21.

The valve shall be the in-line pattern type, be suitable for vertical or horizontal installation and provide positive closure.

3202015 Butterfly valves

Valves shall be manufactured with cast iron bodies and comply with BS EN 593 with the pressure rating to suit the maximum operating pressure of the system.

Valves shall be provided with lever operation up to 150mm diameter and gear operation on 200mm diameter and above.

The valve body liner shall be a WRAS approved EPDM liner with stainless steel disc and shaft. They shall be the short wafer lugged typeand suitable for fitting between flanges complying with BS EN 1092, centrally located by the fixing bolts.

3202016 Float operated valves

All float operated valves and materials shall be WRAS approved.

When installed float operated valves shall be capable of achieving the minimum air gap as required by the Water Supply Regulations.

Ball float valves shall be fitted with a servicing valve on the inlet.

Valves shall be manufactured from cast gunmetal or bronze of a dezincifiable grade.

To prevent back siphonage no connection of a dip tube or silencing pipe to the discharge port shall be permitted.

Float valves fitted to feed and expansion tanks shall be provided with an approved modified float arm such that it allows the float to move a sufficient distance to accept or allow the anticipated expansion/contraction volume of water within the tank.

Float valves to WC cisterns shall be fitted with a collapsible silencing tube in compliance with BS 1212

15 mm float operated valves shall be of the plastic body diaphragm type to BS 1212 unless stated otherwise. Plastic floats shall be to BS 2456.

22 mm and above float operated valves shall be the full bore bronze or gunmetal body equilibrium pattern ball float type to BS 1212 with copper float to BS 1968.

3202017 Stop valves 15mm – 50mm

Stop taps shall be manufactured in bronze or DZR copper alloy and the washer material shall be suitable for the service fluid and operating temperature. The valve shall be the straight pattern type with connections to suit the service pipeline.

Stop valves for potable water supplies shall be in accordance with BS EN 1213. The valves shall be the straight pattern type manufactured in copper alloy with connections to suit the service pipeline. Valves shall be easy clean polished finish where visible.

3202018 Tundishes

Tundishes shall be provided adjacent to equipment as indicated. The units shall be formed from either 3mm copper sheet or mild steel sheet (galvanised after manufacturer). The tundish shall be a tapered reducing cone with a minor diameter to suit the drain line. The major diameter shall be 50 mm larger than the minor diameter, tapering at approximately 30 degrees.

3202019 Draw-off cocks

15 mm – 50 mm draw-off cocks shall be the straight type, gland pattern, taper plug, with gunmetal or bronze body, threaded to BS 21 and complete with brass hose union outlet, screwed blank cap and strap. Plugs shall have a square head with a slot to indicate plug position. A loose malleable iron lever shall be provided with each plug valve. Each draw-off cock shall be hydraulically tested to 20 bar.

3202020 Natural gas service isolation valves

The installation of valves and cocks shall be as indicated and comply with the recommendations of the IGE.

15 mm to 50 mm isolating valve

Type:	Millikan plug valve
Body material:	Cast iron
Pressure rating:	PN 16
End connections:	Threaded to BS 21
Operation:	Wrench
Specification:	Full bore; lubricated parallel plug; self-sealing

Valves shall be complete with a suitable sealing compound to suit the pipeline service media.

65 mm to 200mm isolating valve

Type:	Plug valve BS 5158
Body material:	Cast iron
Pressure rating:	PN 16
End connections:	Flanged to BS EN 1092
Operation:	Wrench
Specification:	Full bore; lubricated parallel plug; self-sealing

Valves shall be complete with a suitable sealing compound to suit the pipeline service media.

3202021 Gas shut-off valves

Solenoid operated gas shut-off valves shall be provided to automatically isolate the gas supply as indicated.

Gas shut-off safety valves shall be in accordance with IGE requirements.

Where possible the valves shall be located remote from the areas being protected, provided that the location will not permit unauthorised interference.

Gas shut-off valves shall comply with BS EN 161 and BS EN 126. Valves shall be electrically operated and arranged to provide a positive shut-off. Valves shall be hand re-settable.

Operation and control of gas shut-off valves shall be as indicated elsewhere.

3202022 Flexible pipe connections (up to 10 bar and 100°C)

Flexible pipe compensators shall be installed on pipe connections to pumps, compressors, chillers, cooling towers, cooling and heating coils on air handling units supported on anti vibration mounts.

Rubber bellows shall be a single convolution of multi-ply EPDM rubber with corrosion resistant steel wire mesh reinforced body.

The units shall be suitable for the working pressure and temperature.

The units shall have an indelible identification indicating manufacturer, date of manufacture, type, size, pressure rating and a batch number.

Ensure flexible connections have a design life of 10 years at 100 °C. Units shall be in accordance with DIN 4809 and after a service life of 10 years at 100 °C must have a burst pressure of not less than 30 bar.

Flanges shall be to BS EN 1092 and shall be able to swivel and be removable.

Threaded ends shall be to BS 21 with one union end.

Where untied bellows are used the manufacturers recommendations for anchors and guides shall be followed.

Tie bars shall be threaded and with adjustable length. Tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar.

Ensure flexible connections are tied when the plant is on vibration isolation mountings.

For working temperatures between 65 °C and 90 °C the bellows shall be steel wire mesh re enforced throughout and manufactured in accordance with DIN 4809.

For working temperatures up to 65 °C the rubber bellows shall be high tensile synthetic fibre reinforced.

For hot water services the bellows liner shall be of a food grade butyl rubber.

3202023 De-aerators and dirt separators (LTHW, CHW)

As indicated, a combined inline de-aerator and dirt separator shall be provided on each closed circuit system where the maximum operating temperature does not exceed 100°C.

The static head for heating systems shall not exceed 15m and 5m on chilled water systems.

Units, including connections, shall be installed in accordance with manufacturer's recommendations.

Where the static head for heating systems exceeds 15m and 5m on chilled water systems separate positive vacuum de-aerator and dirt separator shall be provided on each closed circuit system

Units shall be horizontally mounted in the main supply pipe at the point of maximum system temperature and be adequately supported to be stress free.

The units shall be designed to prevent clogging and to maintain a constant pressure drop across the unit irrespective of the amount of dirt trapped.

Water velocities through the unit shall be in accordance with the manufacturer's recommendations but through a standard unit shall not exceed 1.5 m/s unless otherwise stated. Units for velocities between 1.5 m/s and 3 m/s shall be specially selected.

Casings shall be manufactured from mild steel incorporating internal spiral wound copper mesh system. Connections shall be line size with flanges complying with BS EN 1092 for sizes 50 mm and above.

A drain valve capable of permitting dirt removal while the system is operational shall be provided at the base of each unit.

An automatic air release mechanism shall be provided at the top of the unit comprising solid polycarbonate floats and spring loaded self-closing valve to ensure positive seal to prevent leakages. The valve shall be tamper proof and the unit guaranteed against leakage for a minimum of three years.

The unit shall be suitable for a maximum operating temperature of 110°C and 10 bar maximum pressure unless otherwise stated.

Where indicated, a demountable unit shall be provided in which the lower section can be opened and the internal mechanism removed for cleaning and inspection.

3205000 THERMAL INSULATION

3205001 General requirements

Thermal insulation shall be provided for the following functions:

1. Inhibit freezing
2. Prevent the formation of condensation on pipework, ductwork or equipment
3. To protect personnel from exposure to extremes of temperature
4. Conserve energy for both cooled and heated systems
5. Control process temperatures

Ensure that all thermal insulation is made from materials with zero ozone depletion potential (CFC and HCFC free). Submit to the CA, prior to ordering, written confirmation from the insulation manufacturer(s) that the products to be installed are CFC and HCFC free.

All insulation products shall maintain their thermal performance for a minimum of the plant design life.

Submit to the CA, prior to ordering, details from the manufacturer(s) that define the life expectancy of the materials to be installed.

Submit to the CA, prior to ordering the manufacturer's declared values of thermal conductivity for each material proposed. The declared values shall be appropriate to the mean temperature of the applied insulation and based on results of tests carried out in accordance with the appropriate British Standards.

Where two or more layers of dissimilar insulating material are used, submit to the CA the declared value of thermal conductivity for each layer under the appropriate temperature conditions. The thickness of each layer shall also be stated. Ensure that the interface temperature between the two materials does not exceed the limiting temperature for the material of the outer layer.

All insulating material and associated products shall be applied in accordance with the manufacturer's recommendations and instructions.

All insulating materials, associated products and the completed works shall be accordance with the relevant British Standards and the Building Regulations.

Thermal insulation materials shall be in accordance with BS EN ISO 12241

3205002 Definitions

Chilled water – water after passing through cooling plant (typically 0° C to +10° C)

Primary chilled water – water after passing through cooling plant (typically 0° C to +10° C)

Secondary chilled water - water after passing through cooling plant (typically 10° C to 16° C)

Cold water – water delivered from the mains or natural supply

Warm air ducts – supply or return air ducts in which the air inside the duct is always above ambient.

Air conditioning ducts – supply or return air ductwork where the air may be cooled or dehumidified

Domestic hot water – hot water up to 60° C and up to 65°C for sterilisation

Finishing materials – materials used to cover the insulation whether pre-applied or applied on site

Pre-applied covering – material applied to the insulation prior to delivery to the point of use

Vapour barrier – water vapour retarding layer

Surface temperature – the temperature of the surface to be insulated is taken to be the temperature of the fluid inside the pipe, tank, duct, vessel or other piece of equipment unless otherwise stated

3205003 Workmanship

Thermal insulation work shall be undertaken by specialist firms who are members of the Thermal Insulation Contractors Association and employ skilled craftsman conversant with the class of work.

All thermal insulation materials shall be supplied by manufacturers assessed and registered in accordance with British Standard quality systems standards.

All insulating material and associated products shall be applied in accordance with the manufacturer's recommendations and instructions. The CA will not accept any work not complying with these recommendations.

Thermal insulation shall not be applied to pipework and ductwork services until:

1. The installation, or sections of the installation have been fully pressure tested and all joints proved sound
2. The surface to be insulated has been cleaned, dried and is free of rust, scale and other foreign matter
3. All painting of paintwork has been completed and is dry. Damage caused to pre-painted surfaces during installation shall be repaired at no additional cost
4. Copper pipework has been cleaned thoroughly to remove all traces of surplus jointing flux, building materials and debris, dust and moisture.

Protect all surrounding equipment during installation and leave the area clean and tidy.

Each pipe or duct shall be insulated separately and adjacent parallel pipes or ducts shall not be married together in one insulation covering. There shall be a minimum clearance of 25 mm between adjacent surfaces of insulation.

Where services pass through a fire compartment wall or floor the space between the pipework and the sleeve shall be completely filled with a certified fire resisting material having a performance equal to the fire rating of the structure. In this instance the thermal insulation shall not pass through the sleeve.

All materials delivered to site shall be new and kept dry, and maintained in this condition throughout the progress of the work. Materials shall be stored and adequately protected from damage or deterioration until installed. Protection shall also cover any adverse effects of environmental conditions prevalent in the stored and installed location.

All joints, surfaces, edges and overlaps shall be neatly finished. Where possible arrange overlaps to be on the 'blind' side and parallel to circumferential and longitudinal joints.

Where allowance for expansion and/or contraction has to be accommodated, the insulation shall be finished in a neat and approved manner permitting easy access and disconnection of removable items without disturbing adjacent insulation.

All insulation work shall be to a good standard and the insulating materials, coverings and/or coatings shall be of a uniform thickness throughout.

All insulation shall be complete with a smooth and clean finished surface, no damaged ends or edges and with no irregularities in the thickness of the insulating material or in the material covering. Rigid sections shall be concentric and accurately matched.

Three sections of each type of insulation shall be cut out for inspection by the CA to ensure that the correct thickness has been installed. If the inspection reveals any defects the installer shall cut out a further three sections for inspection. If these also prove defective then the insulation shall be rejected and all insulation shall be stripped off and reinstated at the installer's expense and with no delay to the programme.

All insulation joints shall be installed close butted together. Sections having damaged ends or edges will not be accepted.

Filling voids with adhesive, joint sealer or mastic will not be accepted.

Pipework and ductwork supports are to be provided with inserts, to match the insulation thickness, to enable the insulation finishes to be continuous through the supports.

All support brackets for cold and chilled water services pipework and ducting shall be provided with purpose designed load bearing high density phenolic foam inserts to facilitate installation of a continuous thickness of vapour sealed insulation and finish.

All connections and brackets for sensors, equipment labels and other pipe, duct or equipment mounted accessories shall be extended to project past the insulation thickness and enable items and accessories to be fitted or removed without disturbing the insulation or cladding.

Insulation applied to vessels and pipeline and ductwork ancillaries shall be neatly cut and finished around all manufacturers name and test plates, test points, and dampers to leave these visible.

Where an insulated duct or pipe penetrates the building, adequate precautions shall be taken to prevent the entry of water.

The installer shall ensure that all insulating materials, adhesives and finishes specified herein or added to this contract conform to the requirements of the Local Authority. Installed insulation that is rejected by the Local Authority shall be stripped out and replaced with acceptable materials at the installer's expense and with no delay to the programme.

When directed by the CA arrange for thermal conductivity performance testing of selected materials, at either the manufacturer's works or at an approved testing laboratory. Testing shall be in accordance with the relevant British Standards.

Electrical bonding terminals suitable for connection of 6 mm^2 maximum conductor shall be provided for electrical earthing continuity which shall be carried out in accordance with the latest edition of BS 7671 IEE Wiring Regulations.

Components of dissimilar metals shall not be brought into contact with each other.

3205004 Fire performance

Insulation materials shall have a European Classification for reaction to fire performance of either A1, A2, or B and should not have a potential to flashover. All materials shall be in accordance with BS 476.

All insulation materials installed inside buildings and building service ducts shall conform to Class O (unassisted by facing material) in accordance with the Building Regulations.

The complete assembly of materials, as installed, shall satisfy the 'spread of flame' requirements to Class 1 of BS 476-7.

The insulating material itself (i.e. without any facing) shall satisfy the 'spread of flame' requirements to Class 1 of BS 476-7.

All insulation materials, adhesives, sealants and facings installed shall have a smoke obscuration rating less than 5% when tested in accordance with BS EN ISO 5659.

Where fire and surface spread of flame certificates relate to factory made products, ensure that the certificates are valid where materials are incorporated in pre-insulated equipment.

If there is a potential hazard from contamination by oil or other flammable chemicals, a suitably resistant finish, eg a metal sheet or appropriate non-absorbent coating, shall be applied over the vulnerable areas. The lapped joints of sheet finishes shall be arranged to shed contaminating fluids away from the insulating material.

3205005 Vapour barrier

On surfaces operating below ambient temperature a complete vapour barrier seal shall be provided.

The vapour barrier shall take the form of a coating or sheet material.

Vapour barriers shall be continuous and the integrity maintained. Where this is not possible, the vapour barrier shall be effectively sealed to the pipe to prevent any ingress of moisture or water vapour.

External vapour barriers shall be pre-applied or applied immediately after fitting the insulating material and before the fluid in the pipe, duct, or vessel is cooled.

The function of an external vapour barrier shall not be compromised by its additional use for other purposes e.g. as a form of weather protection or as mechanical protection for the thermal insulation.

Where required separate layers, in the form of coatings or sheet material, shall be used for the individual purposes. Where such additional protection is required, the installer shall ensue that its application does not cause any damage to the vapour barrier during installation and is unlikely to cause damage in service.

The vapour barrier shall not reduce the fire performance of the system as installed below the limit specified as appropriate to the type of application.

The values for water vapour permeance of barriers shall be as BS 5422.

3205006 Materials

All materials shall be strictly in accordance with this specification.

The installer shall ensure that the selected material and finish is suitable for the operating environment.

Materials and their method of application shall not constitute a known risk to health during application or use.

Materials shall be in accordance with BS 2972, BS EN 13467, BS EN 13468:2001, BS EN 13469, BS EN 13470, BS EN 13471 and BS EN 13472

The uses of galvanised or zinc coated insulation steel jacketing and accessories on or near austenitic stainless steel and austenitic nickel steel/alloy equipment and piping, is prohibited.

Dissimilar metals and materials subject to galvanic corrosion shall not be installed in contact with one another.

Where the complete assembly is liable to mechanical damage in use, the final finish shall be sufficiently strong to ensure that the insulation does not become exposed.

Materials in contact shall be compatible and shall not cause corrosion of degradation under normal site conditions.

Insulation materials and finishes shall be inherently proof against rotting, mould and fungal growth and attack by vermin, be non-hygroscopic and in all respect be suitable for continuous use throughout the operating temperatures and within the environment where installed.

Materials shall be free from objectionable odour at the temperature at which they are to be used.

The insulation shall be suitable for the specified conditions of use without the physical properties falling outside the tolerances allowed in the appropriate British Standard for the material.

Protect insulated stainless steel surfaces from the risk of stress corrosion in accordance with the recommendations of BS 5970.

Phenolic foam
All phenolic foam shall be CFC and HCFC free.

Phenolic foam pipe and duct insulation shall have a thermal conductivity of not more than 0.018 W/mK at 10 °C mean temperature.

Materials shall be in accordance with BS EN 13166

Phenolic foam shall not be used on steam services or services operating above 100 °C.

Where there is risk of corrosion being initiated by the pipework insulation a standard passivating bore coating shall be provided to reduce the risk. Any aluminium foil overlaps shall not be tucked in between the butt joints of the insulation sections.

All phenolic pipe insulation shall be a nominal density of 35 kg/m³.

All duct insulation shall be a nominal density of 40 kg/m³.

The perpendicular compressive strength shall not be less than 150 kN/m² for pipe insulation and 100 kN/m² for duct insulation.

Mineral wool
For all mineral wool insulation products, test evidence must be submitted to the CA for approval, prior to ordering, showing that the fibres from which the products are made are not classified as a possible human carcinogen, as detailed by European Directive 97/69/EC and the approved supply list of CHIP98.

Mineral pipe insulation sections shall have a nominal density of not less than 120 kg/m³. Pre-formed pipe sections shall be resin bonded with a thermal conductivity not exceeding 0.038 W/mK at 50 °C mean temperature

Mineral wool duct slab shall have a nominal density of not less than 45 kg/m³ with a thermal conductivity not exceeding 0.04 W/mK at 50 °C mean temperature.

Calcium Silicate
Calcium silicate preformed pipe sections shall have a normal bulk density of 200 – 220 kg/m³ and a thermal conductivity not exceeding 0.05 W/mK at 100 °C mean temperature.

Calcium silicate is prohibited on cold water, chilled water and air conditioning services.

3205007 Insulation thickness

Thickness of insulation shall be in accordance with BS 5422

The insulation thicknesses stated in the following tables are given for thermal conductivities appropriate to the usual materials used for the application. The thickness for intermediate thermal conductivities and pipe sizes shall be deduced by calculation or interpolation in accordance with the relevant British Standards.

Pipe nominal diameters stated in insulation thickness tables are based upon steel pipework. Where copper or plastic pipwork is used the equivalent outside diameter of the pipe shall be used. Reference should be made to BS EN 10255 and BS EN 10220.

If the thickness given in, or interpolated from, the tables in the British Standard or the specification do not correspond with available thickness, the nearest higher available thickness shall be used.

In multi-layer applications, where material thickness is rounded up to suit available commercial thickness, the installer shall ensure by calculation (in accordance with the appropriate British Standard) that each interface temperature is below the maximum continuous operating temperature of the materials involved.

Minimum insulation thickness for chilled and cold water supplies to prevent condensation (BS 5422 Table 8)

Ambient temperature 25 °C Relative humidity 80%
Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.038 W/mK
Emissivity outer surface = 0.05 (low eg aluminium, bright)

Steel pipe nominal pipe size (mm)	Temperature of contents (°C)					
	+ 10		+ 5		0	
	Insulation thickness (mm)					
	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
15	15	20	15	25	20	30
20	15	20	15	30	20	35
25	15	25	20	30	25	35
32	15	25	20	30	25	40
40	15	25	20	35	25	40
50	15	30	25	35	30	45
65	20	30	25	35	30	45
80	20	30	25	40	30	50
100	20	35	25	40	30	50
150	20	40	30	50	35	60
200	25	40	30	50	40	60
250	25	40	35	50	40	70
300	25	40	35	60	40	70
Flat surfaces	30	52	40	70	50	90

λ=thermal conductivity at mean temperature of insulation.
Thicknesses given in the above table are calculated specifically against the criteria stated.

Environmental insulation thickness for non-domestic heating installations to control heat loss (BS 5422 Table 12)

Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.038 W/mK

Steel pipe nominal pipe size (mm)	Hot face temperature (°C)				
	+ 75		+ 100		+ 150
	Insulation thickness (mm)				
	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Mineral wool
15	15	35	15	40	60
20	15	35	20	40	60
25	15	35	20	45	70
32	20	40	25	45	70
40	20	40	25	50	70
50	20	40	25	50	70
65	20	40	30	50	80
80	25	40	30	60	80
100	25	45	30	60	80
150	30	50	35	60	90
200	30	50	35	60	90
250	30	50	35	65	90
300	30	50	40	65	90
Flat surfaces	30	50	40	70	90

λ=thermal conductivity at mean temperature of insulation.
Thicknesses given in the above table are calculated specifically against the criteria stated.

Environmental insulation thickness for non-domestic hot water service areas to control heat loss (BS 5422 Table 13)

Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.038 W/mK

Steel pipe nominal pipe size (mm)	Water temperature of 60°C	
	Insulation thickness (mm)	
	Phenolic foam	Mineral wool
15	15	30
20	15	35
25	15	35
32	20	35
40	20	40
50	20	40
65	20	40
80	25	40
100	25	45
150	25	50
200	30	50
250	30	50
300	30	50
Flat surfaces	30	50

λ=thermal conductivity at mean temperature of insulating material
Thicknesses given in the above table are calculated specifically against the criteria stated.

Minimum insulation thickness required to give protection against freezing under specified commercial and institutional conditions (BS 5422 Table 23)

Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.038 W/mK

Water temperature		20C		20C	
Ambient temperature		-60C (indoor unheated)		-100C (outdoor)	
Evaluation period		12h		12h	
Permitted ice formation		50%		50%	
Pipe size (mm)		Thickness of insulation (mm)			
Outside diameter (mm)	Bore (mm)	Phelonic foam	Mineral wool	Phenolic foam	Mineral wool
Copper Pipes					
15	13.6	25	100	70	*
22	20.2	15	20	25	70
28	26.2	15	20	15	35
35	32.6	15	20	15	20
42	39.6	15	20	15	20
54	51.6	15	20	15	20
76.1	73.1	15	25	15	25
108	105.0	15	25	15	25
Steel Pipes					
21.3	16.0	20	60	45	*
26.9	21.6	15	25	20	65
33.7	27.2	15	20	15	35
42.4	35.9	15	20	15	20
48.3	41.8	15	20	15	20
60.3	53.0	15	20	15	20
76.1	68.8	15	25	15	25
88.9	80.8	15	25	15	25

λ=thermal conductivity at mean temperature of insulating material
Thicknesses given in the above table are calculated specifically against the criteria stated.

The calculated thickness is too large to be applied in practice to protect small diameter pipes against freezing under extreme conditions. Therefore to provide the appropriate level of frost protection it will be necessary to provide additional heat to the system by trace heating. The installer shall submit to the CA details of their proposals to give protection against freezing for approval prior to commencement of the works.

Environmental insulation thickness for ductwork carrying warm air (BS5422 Table 11)

Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.04 W/mK

Temperature difference between air inside ductwork and ambient air (°C)					
10		25		50	
Environmental insulation thickness (mm)					
Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
25	40	25	50	40	65

λ=thermal conductivity at mean temperature of insulating material
Thicknesses stated in the above table are calculated specifically against the criteria stated.

Minimun insulation thickness for condensation control on ductwork carrying air in ambient conditions (BS5422 Table 10)

Ambient temperature 25 °C
Relative humidity 80%
Dewpoint temperature 21.3 °C

Phenolic foam λ = 0.018 W/mK
Mineral wool λ = 0.04 W/mK
External surface emissivity 0.05 (low eg aluminium, bright)

Minimum air temperature inside duct (°C)							
15		10		5		0	
Minimum thickness of insulating material (mm)							
Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool	Phenolic foam	Mineral wool
20	29	30	52	40	75	50	96

λ=thermal conductivity at mean temperature of insulating material at 10 (°C)
Thicknesses given in the above table are calculated specifically against the criteria stated.

3205008 Application

Heating, hot water and condenser water pipework

Internal pipework (concealed)
Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' foil facing.

Sections shall be close butted and all longitudinal and circumferential joints sealed with 'Class 'O' aluminium foil self-adhesive tape applied over a clean surface and firmly pressed down. The minimum width of aluminium foil tape shall be 50mm. Where provided, the longitudinal joint overlap shall be sealed with a suitable adhesive to the manufacturers recommendations.

Sections shall be firmly secured by additional bands of aluminium foil tape applied circumferentially at not greater than 300 mm centres, ensuring a minimum of three self-adhesive bands per metre run.

The insulation shall be further retained in position by light gauge aluminium bands at a maximum of 450 mm spacing and not nearer than 50 mm to the end of the section.

All bends, sets, tees and elbows are to be correctly mitred and segmented with insulation to the necessary thickness to match the adjoining. All joints to be securely sealed with 50 mm wide Class 'O' aluminium foil self-adhesive tape.
The insulation shall not be left exposed at termination points. Insulation edges shall be over taped and returned and adhered to the exposed insulation face. Ensure the aluminium foil does not come into contact with the insulated metal face.

Bends, fittings, flanges and pipe clips shall also be insulated with preformed sections of foil faced insulation, cut to suit on site with joints sealed with adhesive and matching self adhesive tape. Bends shall be insulated with mitred segments.

If cold and damp conditions are anticipated during installation, consideration shall be given to utilising a Class 'O' aluminium foil tape with an acrylic adhesive.

Plantrooms
Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' aluminium foil facing as for internal pipework and finally protected with aluminium cladding.

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

External Pipework

Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' aluminium foil facing as for internal pipework and finally protected with aluminium cladding or polyisobutylene (PIB) sheeting

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

All joints and protrusions through the cladding shall be sealed with an approved sealant to provide a water and weatherproof finish. The cladding shall be additionally secured with metal banding at 450mm centres. The banding shall be selected to complement the sheet cladding and not contribute to bi-metal corrosion.

External pipework and pipework in purpose built external trenches
All pipework shall be insulated with rigid preformed Class 'O' aluminium foil faced pipe sections and finally protected with polyisobutylene (PIB) sheeting.

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

Chilled and cold water pipework

Internal pipework (concealed)
Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' foil facing to form a continuous vapour barrier.

Sections shall be close butted and all longitudinal and circumferential joints sealed with 'Class 'O' aluminium foil self adhesive tape applied over a clean surface and firmly pressed down. The minimum width of aluminium foil tape shall be 50mm. Where provided, the longitudinal joint overlap shall be sealed with a suitable adhesive to the manufacturers recommendations.

Sections shall be firmly secured by additional bands of aluminium foil tape applied circumferentially at not greater than 300 mm centres, ensuring a minimum of three self adhesive bands per cut section.

All bends, sets, tees and elbows are to be correctly mitred and segmented with insulation to the necessary thickness to match the adjoining. All joints to be securely sealed with 50 mm wide Class 'O' aluminium foil self adhesive tape.

The insulation shall not be left exposed at termination points. Insulation edges shall be over taped and returned and adhered to the exposed insulation face. Ensure the aluminium foil does not come into contact with the insulated metal face.
Bends, fittings, flanges and pipe clips shall also be insulated with preformed sections of foil faced insulation, cut to suit on site with joints sealed with adhesive and matching self - adhesive tape. Bends shall be insulated with mitred segments.

If cold and damp conditions are anticipated during installation, consideration shall be given to utilising a Class 'O' aluminium foil tape with an acrylic adhesive.

All ends of the insulation and points where the covering is penetrated shall be sealed so that the continuity of the vapour barrier is maintained.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature. A suitable vapour barrier sealant shall be applied to moisture proof the interface between the insulation and the underneath metal face at all termination points and the vapour barrier shall be returned affectively and sealed to the butt end of the insulation section sa as not to allow any ingress of moisture or water vapour.

All metal parts of valves, strainer caps, etc., projecting beyond the insulation shall be painted with an approved anti-condensation compound. All mild steel pipework prior to being insulated shall be painted two coats of red oxide paint. Particular care shall be taken to ensure neither water nor water vapour enter the insulation system via valve spindles etc.

Plantrooms
Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' aluminium foil facing as for internal pipework and finally protected with aluminium cladding.

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

Care shall be taken to avoid damaging the integrity of the underlying vapour barrier facing.

Rivets and screws which may damage the vapour barrier are not to be used. The cladding shall be secured with aluminium bands at 150 mm centres, of a suitable type and dimension.

External Pipework
Pipework shall be insulated with approved rigid preformed pipe sections having a factory applied bright Class 'O' aluminium foil facing as for internal pipwork and finally protected with aluminium cladding or polyisobutylene (PIB) sheeting

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

All joints and protrusions through the cladding shall be sealed with an approved sealant to provide a water and weatherproof finish. The cladding shall be additionally secured with metal banding at 450mm centres. The banding shall be selected to complement the sheet cladding and not contribute to bi-metal corrosion.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature.

External Pipework and Pipework in purpose built external trenches

All pipework shall be insulated with rigid preformed Class 'O' aluminium foil faced pipe sections and finally protected with polyisobutylene (PIB) sheeting.

Workmanship and installation requirements for preformed pipe sections shall be as stated elsewhere for internal pipework except aluminium bands are not required.

Particular care shall be taken to vapour seal insulation termination points on pipework, valves and equipment operating below ambient temperature.

Internal ductwork (concealed from view) - air conditioning and warm air
All rectangular ductwork shall be insulated with either mineral wool having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970 or phenolic foam insulation having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970

Circular and oval ductwork shall be insulated with either flexible duct mineral wool insulation having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970 or phenolic foam insulation having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970

For all mineral wool insulation products, test evidence must be submitted to the CA for approval, prior to ordering, showing that the fibres from which the products are made are not classified as a possible human carcinogen, as detailed by European Directive 97/69/EC and the approved supply list of CHIP98.

All insulation slabs shall be cut to fit on site.

The insulation shall be bonded to the ductwork surfaces with a contact adhesive suitable for the materials and applied in accordance with the manufacturers' instructions.

The insulation on the underside of the ductwork shall be additionally secured by means of suitable nylon insulation hangers, fixed at maximum 300mm centres. Insulation hangers shall be additionally attached to the vertical faces of the duct where mineral wool insulation is used. Where support hangers puncture the foil, they shall be sealed using aluminium foil tape to maintain the vapour barrier.

All joints shall be sealed with 100mm minimum wide self-adhesive aluminium reinforced foil tape to form a continuous vapour barrier seal, including ductwork and equipment flanges which shall be encased. All insulation slabs shall be secured with a minimum of three self -adhesive tape bands per linear metre of ductwork.

Where a vapour barrier is required, provision should be made for exposed slab edges to carry the aluminium foil to the adjoining edge.

Insulation shall be additionally supported by means of 22 swg x 50mm mesh galvanised wire netting, drawn tightly around the insulation with 150 mm overlaps at edges and secured with 0.9 mm galvanised lacing wire. Care shall be taken when applying the wire mesh support to avoid damaging or puncturing the vapour barrier.

Ductwork in plantrooms - air conditioning and warm air
Rectangular ductwork shall be insulated as for internal ductwork and finally protected with aluminium cladding.

Extreme care shall be exercised in the case of cladding air conditioned supply air ductwork to ensure any riveting of the aluminium cladding does not perforate the aluminium foil facing on the insulation and destroys the vapour barrier.

Circular/oval ductwork shall be insulated as for rectangular ductwork and finally protected with aluminium cladding.

External Ductwork
Rectangular and circular/oval ductwork shall be insulated as for internal ductwork and finally protected with aluminium cladding.

Insulation for the top surface of horizontal ducts shall be factory prepared to provide a fall of 1:25 to ensure that surface water does not cause ponding on the upper surface. The minimum thickness of insulation shall be maintained including at all flanges and supports.

Vertical cladding joints shall overlap to ensure no top metal edge exposure and prevent water penetration.

All joints and fixing shall be sealed with mastic to provide a water proof installation and maintain the integrity of the vapour barrier.

Heat exchangers, calorifiers and cylinders
Circular calorifiers and cylinders shall be insulated with mineral wool flexible duct insulation having a factory applied Class 'O' facing of reinforced aluminium foil.

Insulation shall be cut to suit on site and bonded to surfaces by means of a suitable adhesive, applied in accordance with the manufacturer's requirements.

Thickness of insulation shall be in accordance with BS 5422

The insulation shall be protected with aluminium sheeting, all joints lapped and neatly secured with sheridised self-tapping P.K. screws or pop rivets along longitudinal seams.

Before applying the cladding the insulating material shall be completely smooth finish with no gaps or crevices between sections, ensuring that it is tight fitting adjacent to all connections, inspection covers and other protrusions.

The cladding when finished shall be free from dents, burrs, sharp corners and all tappings and protrusions such as access covers, bosses, tappings, etc., shall be separately clad in

the same material but removable for inspection purposes. Fit cut outs with purpose made over-plates or collars.

Remove manufacturer's name plate and re-fix on cladding.

Tanks and cisterns
Cold water storage tanks and cisterns shall be insulated with either mineral wool having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970 or phenolic foam insulation having a factory applied bright Class 'O' reinforced aluminium facing complying with BS 5422 and BS 5970

Thickness of insulation shall be in acordance with BS 5422

Insulation shall be bonded to tank sides by means of suitable adhesive, applied in accordance with the manufacturer's requirements.

All insulation slabs shall be closely butted together and joints sealed by means of matching self adhesive tape 100mm. wide. Any exposed edges of the insulation and any points where the covering is penetrated shall be sealed, using a suitable sealant.

Tanks shall be insulated on the sides and top only - not on their undersides.

Insulation for loose covers and access manholes shall be made in separate sections completely removable.

The insulation shall be protected on the four vertical corners with 75mm. x 75mm. aluminium angles.

The insulation surfaces shall be protected by means of aluminium sheeting, all overlaps being secured with sheridised self-tapping PK. screws or pop rivets.

Ensure the vapour barrier is not damaged when applying the sheet metal cladding.

Insulated support blocks
At the points of support where insulation bears the weight of pipework and contents, purpose designed load bearing, high density blocks of an approved material shall be installed at all support positions to facilitate installation of a continuous thickness of vapour sealed insulation and finish.

The pipe insulation shall be butted up to the block and the joints sealed with a suitable adhesive tape to provide a continuous vapour seal through the support.

Sharp edges on metal support brackets/clips shall be ground smooth to ensure that the brackets/clips do not perforate the foil facing, thus destroying the vapour seal.

Where pipework is supported on steel bearers/rollers, purpose designed high density blocks of an approved material fitted with galvanised metal wearing plates shall be used. The support blocks shall be butt jointed, wrapped with adhesive tape and vapour sealed.

Valve and flange insulation
Provide thermal insulation to all valves, flanges, strainers and all ancillaries. The insulation shall be suitable for the service to be insulated and provide the same thermal performance as the adjoining pipework and maintain the continuity of the vapour barrier where required.

All chilled water valves and flanges shall be insulated and complete with vapour barrier.

Flexible thermal insulation jackets

Heating and hot water valves up to 50 mm shall be provided with flexible thermal insulation jackets as specified.

Flexible thermal insulation jackets shall be secured by way of draw string collars and Velcro fasteners. The outer layer of the valve cover shall be aluminised polyester film coated glass

fibric. The inner layer shall be a woven glass fibre fabric, capable of withstanding a continuous hot face temperature of 260 °C. Flexible thermal insulation jackets shall be removable and reusable.

Valve and flange aluminium casing
Aluminium boxes shall be the split casing type fabricated from 0.91mm aluminium sheet or 0.7 mm fitted with spring clip fasteners and neoprene or similar seals. The internal insulating material lining shall have the same thermal performance as the adjoining insulation and be secured to ensure the lining will not collapse when the box is removed and re-installed. Aluminium boxes shall be re-useable and facilitate removal without disturbing the adjacent insulation.

All valves shall be provided with valve boxes unless otherwise stated.

Aluminium cladding
Aluminium cladding shall be formed to fit tightly over the outer circumference of the insulation with longitudinal overlaps of not less than 40 mm the outer part of the overlap to be secured with self-tapping screws or rivets of the appropriate type at centres of not more than 150mm. All longitudinal joints shall be hidden from view as far as possible.

Circumferential overlaps to be not less than 40 mm and secured with secured with self-tapping screws or rivets of the appropriate type, not less than four, equally spaced. One circumferential joint should be left free at maximum intervals of 5 metres to allow for expansion and contraction.

All joints shall be so arranged as to shed liquids and shall be sealed with a suitable gun applied water resistant sealant.

All bends and fittings shall be covered with matching aluminium sheet cladding tailored to fit the application but using specially segmented purpose made pieces, or mitred bends where applicable.

All insulation termination points shall be trimmed with compatible aluminium coiled end capping pieces secured over the aluminium cladding with closed head pop rivets.

All aluminium metal work shall be pre-formed, neatly and correctly installed, and manufactured to ensure a smooth, clean, uniform installation free from sharp and dangerous edges.

Minimum thickness of aluminium cladding:

	Minimum thickness of aluminium cladding (mm)
Pipework up to 150 mm OD above 150mm OD	 0.60 0.71
Ductwork	0.71
Heat exchangers and vessels	0.9
Flange and valve boxes	0.91
Removable covers	0.91

Polyisobutylene (PIB) sheeting
Polyisobutylene (PIB) sheeting shall have a minimum thickness of 0.8mm and of tensile strength not less than 3.4 MN/m2 lapped on all circumferential and longitudinal joints and sealed using a solvent/cold welding agent. Points where the PIB sheeting is penetrated due to protrusions shall be sealed with a suitable sealant to the manufacturer's recommendations.

Adhesives and welding agents used shall as recommended by the Polyisobutylene (PIB) sheeting manufacturer. Under no circumstances will an alternative adhesive or welding agent be permitted.

PIB shall be applied in accordance with the manufacturer's instructions.

3206000 IDENTIFICATION OF SERVICES

3206001 General requirements

All methods of identification shall be compatible with the pipe and operating conditions.

Identification of services shall comply with BS1710 and BS 4800.

When it is required to supplement the warning colour with warning sign to comply with statutory requirements reference should be made to BS 5499: Part 5.

Identification bands shall be applied in a logical and tidy manner with lettering and flow arrows clearly visible. Where several pipelines are installed in parallel to each other the identification bands shall be applied at the same location on each pipe.

3206002 Valve labels and charts

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the valve chart (s) and record drawings. The labels shall be made from 3 ply (black/white/black) traffolyte material showing white letters and figures on a black background. Labels shall be tied to each valve with chromium plated linked chain.

A wall mounted, glass covered plan to the approval of the CA shall be provided and displayed in each plantroom showing the plant layout with pipework, valve diagram and valve schedule indicating size, service, duty, etc.

3206003 Identification of services

Pipework and ductwork shall be identified by colour bands 150mm. wide or colour triangles of at least 150mm/side. The bands or triangles shall be applied at termination points, junctions, entries and exits of plantrooms, walls and ducts, and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

3206004 Pipework services

Basic colours for pipeline identification:

Pipe contents	BS identification colour reference BS 4800	Basic identification colour names
Water	12 D 45	Green
Steam	10 A 03	Silver-grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow/Brown
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below:-

Pipeline Contents	Colour Band to BS 4800
Water Services:	
Cooling	00 E 55
Fresh/drinking	18 E 53
Boiler feed	04 D 45/00 E 55/04 D 45
Condensate	04 D 45/14 E 53/04 D 45
Chilled	00 E 55/14 E 53/00 E 55
Central Heating Services:	
below 100C	18 E 53/04 D 45/18 E 53
above 100C	04 D 45/18 E 53/04 D 45
Cold water storage tanks	00 E 55/18 E 53/00 E 55
Hot water supply	00 E 55/04 D 45/00 E 55
Hydraulic power	04 C 33
Sea/river untreated	Basic colour only
Fire extinguishing	04 E 53
Steam Services	Basic colour only
Compressed air	Basic colour only
Vacuum	White
Natural Gas	10 E 53
Oils:	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic power	04 C 33
Transformer	04 D 45
Drainage and other fluids:	Basic colour only
Electrical Services:	Basic colour only

In addition to the colour bands specified above all pipework shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

Service	Marking
High temperature hot water	HTHW
Medium temperature hot water	MTHW
Low temperature hot water	LTHW
Chilled water	CHW
Condenser water	CONDW
Steam	Steam
Condensate	Condensate
Domestic hot water service	HWS
Potable water	MWS
Cold water down service	CWDS

Pipes shall have the letters ‘F’ and ‘R’ added to indicate flow and return respectively as well as directional arrows.

3206005 Ductwork services

The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150mm. length per side. One apex of the triangle shall point in the direction of airflow

Service	Colour	BS.4800 Colour reference
Conditioned Air	Red and Blue	04 E 53/18 E 53
Warm Air	Yellow	10 E 53
Fresh Air	Green	14 E 53
Exhaust/Extract/Re-circulated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual duct system:		
hot supply air	Red	04 E 53
cold supply air	Blue	18 E 53

In addition to the colour triangles specified above all ductwork shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply air	**S**
Return air	**R**
Fresh air	**F**
Exhaust air	**E**

The colour banding and triangles shall be manufactured from self-adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape

3206006 Identification of plant

Each item of plant and equipment shall be labelled with a traffolyte or metal label indicating its unique reference code as used in the operating and maintenance documentation.

The plant numbering system shall be agreed with the CA prior to the commencement of the Works.

The plant numbering system shall be fully compatible with any existing numbering system.

All items of plant and equipment shall be provided with a manufacturer's nameplate indicating the plant type, reference, serial number, year of manufacturer, performance and electrical data.

Pressure vessels which have been hydraulically tested at the manufacturer's works shall indicate the test pressure, working pressure and date of test.

3207000 NOISE AND VIBRATION

3207001 General requirements

Attenuators and other noise control equipment shall be installed to achieve the stated noise levels with minimum resistance to air flow.

The installer shall take due consideration of the planning restrictions relating to the acoustic requirements of the project and ensure compliance with the plant operating at all design configurations.

All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be selected to suit the machinery.

Noise level data for all items of plant, based on octave band analysis data, shall be submitted to the CA prior to ordering.

Where sound power levels have been indicated for specific plant items these shall be the maximum sound power levels.

The installer shall undertake the final selection of sound attenuation equipment to satisfy the particular performance requirements of the specification and the spatial allowances based on final plant/equipment selection and final co-ordinated installation drawings

The installer shall undertake the redesign of the final acoustic requirements associated with approved alternative equipment or materials which subsequently varies the Works in any way whatsoever.

All attenuating materials shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited. Non-flammable adhesives shall not be used.

All acoustic components shall be made from materials with zero ozone depletion potential (CFC and HCFC free). Submit to the CA, prior to ordering, written confirmation from the manufacturer(s) that the products to be installed are CFC and HCFC free.

For all acoustic infill material test evidence must be available and submitted to the CA showing that the fibres from which the products are made are not classified as a possible carcinogen as detailed by European Directive 97/69/EC. Fibres shall also comply with the requirements as stated elsewhere and with HSE guidelines.

Ensure that isolation mounts are not bridged by rigid connections such as electrical conduits or obstructions underneath the floating equipment.

Provide acoustic seals around all pipework and ductwork penetrations through plantroom enclosures and other enclosures where acoustic separation is required and indicated.

3207002 Attenuators

Attenuators shall be installed in accordance with manufacturer’s recommendations.

Attenuators shall be delivered to site and stored with ends sealed to prevent contamination or damage.

The direction of airflow through the attenuator shall be clearly marked on the external casing.

Attenuator ratings shall be determined in accordance with BS EN ISO 7235.

Static pressure loss of attenuators shall not exceed those specified at the required airflow.

Attenuators shall be selected such that the following pressure drops are not exceeded for the various background

NR	Maximum pressure drop (Pa)
20	35
25	35
30	63
35	75
40 and above	100

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

Casings shall be manufactured from galvanised mild steel sheet of not less than 0.8mm thickness with continuously lock-formed joints and constructed to minimise air leakage. The casing construction shall be in accordance with the ductwork specification for the connecting ductwork as stated elsewhere.

The acoustic infill material shall be inorganic mineral or glass fibre of a density sufficient to obtain the specified acoustic performance and packed to eliminate voids due to vibration and settling. The infill materials shall be non-combustible, inert, non-hygroscopic, rot and vermin proof. All internal surfaces shall be sealed against fibre release.

The infill material shall be guaranteed against erosion and to enable airway velocities of up to 25 m/s.

Infill materials shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited.

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

Splitters shall have aerodynamic leading and trailing fairings. Square ends will not be acceptable unless approved by the CA.

Side attenuator elements shall be fitted as standard to reduce noise breakout and assist in smooth airflow.

Splitter elements in straight rectangular attenuators shall stand vertically, and shall be a tight-fit within the casing.

L-section and T-section splitter attenuators shall be designed for smooth air flow. Splitters in bend attenuators shall be fitted perpendicular to the plane of the bend.

Horizontal splitter elements shall be stiffened to prevent flexing or airway restriction and provide retention of acoustic infill.

Splitters shall preferably be in a vertical orientation and shall be a tight-fit within the casing. The configuration shall have a regular splitter/airway dimension across the full width of the unit.

Where required intermediate stiffeners shall be fitted for rigidity.

In plantrooms it is preferred that attenuators be located immediately before penetration of the plantroom enclosure but where this is not possible external acoustic lagging shall be

installed on the ductwork between the attenuator outlet and the plantroom enclosure to prevent noise break in to the distribution ductwork.

Attenuators located in kitchen extract systems shall have an approved protective coating to permit cleaning and grease removal.

3207003 Air transfer/cross talk attenuators

Provide straight through attenuators for air transfer and cross talk applications as indicated in schedules or on drawings.

The air transfer system shall match the acoustic performance of the intervening wall or ceiling system. If cross talk is being assessed between two adjacent spaces with different noise criteria, then the lowest criteria shall be used.

For non-ducted type units the attenuator cross section shall be sized to maintain a maximum pressure drop of 5 Pa.

For ducted type units the attenuator cross section shall be sized to maintain a maximum pressure drop of 10Pa.

Construction of air transfer/cross talk attenuator shall be as described under the clause attenuators.

3207004 Acoustic duct linings

Acoustic linings shall not be used inside ductwork unless indicated as being required and approved by the CA.

Linings shall not reduce the required airway dimensions and the size of ductwork shall be increased such that the internal cross-sectional area is maintained at the size indicated. Insulation materials shall accurately fit the internal surfaces of the duct.

Inspection covers, in accordance with DW144, shall be provided at both ends of ductwork sections containing sound absorbent linings.

The lining material shall be protected against product migration and erosion and shall be securely retained by perforated galvanised steel sheet, hot dip galvanised after perforation.

Edges and joints shall be protected to prevent the lining lifting due to the action of the airflow.

3207005 Acoustic enclosures

Acoustic enclosures shall provide an overall sound reduction index (SRI) of not less than that stated elsewhere. Full allowance shall be taken of any loss due to doors, windows, ventilation openings and panel joints.

Doors, access panels, windows and ventilation ducts or electrical cable penetrations shall be treated so as to maintain the specified acoustic performance of the assembled enclosure.

Panels shall be structurally self-supporting without additional stiffening. All necessary steelwork shall be provided and be galvanised after manufacturer.

Demountable sections shall be designed to allow safe working and handling and provide easy disassembly and re-assembly.

Removable panels shall give access to items requiring cleaning, adjustment, replacement and other maintenance. Where enclosures are designed for personnel access, internal lighting and viewing panels shall be provided. Access doors shall be open from both sides.

Enclosure panels shall be constructed from galvanised mild steel sheet at least 1.6 mm thick or as otherwise stated. The absorbent internal lining shall be faced with a protecting membrane and be retained by perforated galvanised mild steel sheet. The infill media shall be compression packed to prevent settlement together with provision inside the panel to prevent settling as necessary. Fibres of infill media shall be comply with the requirements as stated elsewhere.

The assembled enclosure shall be designed and constructed to withstand the particular site operating conditions. External enclosures shall be suitably weatherproofed and designed for the site conditions including wind forces, snow loads etc.

The internal surfaces of the enclosure panels shall be designed to give the following minimum average sound absorption coefficients when tested in accordance with BS EN ISO 354.

Frequency (Hz)	125	250	500	1k	2k	4k
Minimum average absorption coefficient (α)	**0.2**	**0.5**	**0.7**	**0.8**	**0.8**	**0.7**

The enclosure shall be isolated from the noise-producing equipment and also be isolated from the building structure.

Provisions shall be made to dissipate heat emitted from the noise-producing equipment where necessary.

3207006 Acoustic louvres

Acoustic louvres shall provide insertion losses under operating conditions of not less than those stated elsewhere. Static pressure losses, under maximum operating duties shall not exceed those stated elsewhere.

The louvre assembly shall be constructed to provide inherent structural rigidity and ensure adequate blade support across the whole louvre width.

The louvre framework shall be constructed from suitable gauge galvanised mild steel.

The louvres shall be designed to prevent the penetration of water due to rain, snow, hail etc under all meteorological conditions.

Louvre blades shall be constructed from galvanised mild steel not less than 0.7mm thickness and shall be of an aerofoil or similar configuration. Each blade shall positively retain the acoustic infill and shall have a galvanised perforated sheet steel lower and solid upper face.

The acoustic infill within the blades shall consist of inert, rot and vermin proof, non-hygroscopic mineral wool or glass fibre of a density sufficient to achieve the stated acoustic performance, packed and compressed so as to eliminate voids due to settling. The acoustic infill shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited. Fibres of infill media shall be comply with the requirements as stated elsewhere.

The acoustic louvre assembly shall be finished in a high quality polyester powder paint as stated elsewhere ensuring that all surfaces are thoroughly prepared and cleaned prior to application.

The louvers shall be supplied complete with all necessary fixings, flanged, etc for installation into the builders work or other suitable opening or support frame.

Acoustic louvers shall be complete with integral bird screens of galvanised mild steel or aluminium mesh, fixed to the internal face ensuring there are no protruding edges. The mesh pitch shall not exceed 15mm x 15mm square grid. Alternatively, insect mesh is to be included where indicated.

All gaps between the outside of the louver frame and the builders work opening or duct shall be made good and sealed to the full depth with dense grout and/or dense non-hardening mastic sealant. Mastic sealant design life shall be a minimum of 10years unless otherwise stated.

All acoustic louvers shall be delivered to site with protective packaging and labelled to indicate unit reference, location and description.

The installer shall be responsible for advising the acoustic louvre supplier of the final manufacturing sizes allowing for suitable tolerance spacing to builders work, cladding or ductwork.

3207007 External acoustic duct lagging

Provide external acoustic lagging where indicated. It shall consist of a resilient layer wrapped around the duct together with an outer high mass skin. The total composite shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited.

All thermal insulation shall be made from materials with zero ozone depletion potential (CFC and HCFC free). Submit to the CA, prior to ordering, written confirmation from the insulation manufacturer(s) that the products to be installed are CFC and HCFC free.

The thermal performance of all insulation shall be maintained for a minimum of the plant design life. Thickness of insulation shall be in accordance with BS 5422.

On surfaces operating below ambient temperature a complete vapour barrier seal shall be provided.

Vapour barriers shall be continuous and the integrity maintained.

Proprietary acoustic lagging products shall be approved by the CA before commencement of the Works. Submit to the CA, prior to ordering, details that define the materials to be used including thermal conductivity and acoustic performance, life expectancy, method of application and fire performance.

All joints of the outer mass skin system shall be staggered and lapped by no less than 50mm. Direct butt joints shall not be permitted.

All insulating material and associated products shall be applied in accordance with the manufacturer's recommendations and instructions.

Fibres of infill media shall be comply with the requirements as stated elsewhere.

3207008 Vibration isolation

General
Supply and install plant and equipment isolators as stated elsewhere to ensure that vibration from plant is not transmitted to the building, other supporting structure, pipework or ductwork. All anti-vibration mountings shall be supplied and fixed by the installer.

Isolators must be selected for the operating weight of equipment and shall be positioned for equal deflection.

Mountings shall be clearly and permanently marked with their load capacity and colour coded to BS1726 to enable easy identification during installation.

Mountings shall be constructed of materials that are passive or have low levels of electrolytic action

The installer shall be responsible to ensure that all mountings are appropriate for the design loads, operating and environmental conditions that will prevail. Particular attention shall be paid to mountings exposed to atmospheric conditions to prevent corrosion.

The installer shall provide all necessary information, including but not limited to actual plant loads and running speeds, to the vibration isolation specialist/supplier to enable final isolator selections to be made. Selection shall allow for uneven load distributions such that the minimum deflection is achieved on all vibration isolators under normal operating conditions.

The installer shall confirm to the CA the final vibration control equipment selections and their compliance with the specification prior to commencement of the Works.

Pipework and ductwork connections to equipment mounted on anti-vibration mounts shall not be rigid. Flexible couplings or connections shall be installed.

Helical steel spring mounts
Helical steel spring mounts shall comprise single or multiple spring elements fitted to a plated steel base plate. A rubber/neoprene pad shall be bonded beneath the bottom plate.

All mountings shall incorporate a lockable levelling device. There shall be provision for bolting through the base plate in at least two places.

The springs shall have an outside diameter of not less than 75% of the operating height and be selected to have at least 50% overload capacity.

Vertically restrained spring mounts
Mountings shall be as described under the clause for helical steel spring mounts but include a mechanism that provided an adjustable vertical limit stop to prevent spring extension when load is decreased.

Mountings used in the external environment shall be adequately protected against environmental and atmospheric degradation.

Turret compression mountings
Turret compression mountings shall comprise a synthetic formulated rubber compound turret in compression between two steel plates with complete lateral freedom for deformation. All metal surfaces must be covered to avoid corrosion and have friction pads to and bottom. Bolt holes shall be provided in the top and bottom plates to facilitate fixing.

The rubber turret shall be resistant to oil, sunlight, corrosion and ozone.

Turret compression mountings shall not be employed where ambient or equipment temperatures exceed the manufactures recommendations.

Helical spring compression hangers
Spring compression hangers shall comprise a helical steel spring fitted with acoustic rubber end caps fitted incorporated within a steel hanger box.

The lower box hole diameter shall be adequately sized to provide free drop rod movement up to 15° from vertical in any direction in order to compensate lateral movement.

The hanger bracket shall be designed to carry five times overload without failure.

Where hangers incorporate a positioning device, the adjustment system shall incorporate a locking mechanism to prevent the hanger going out of adjustment as a result of vibration or unauthorised tampering.

Spring hangers shall be installed to support all pipework and ductwork connected to rotating and reciprocating machinery within plantroom areas or within 30 m of the plant which ever is the lesser.

The hanger bracket shall be designed to carry five times overload without failure.

Hangers shall be colour coded for identification.

Neoprene element hangers
The hanger shall be essentially as described under the clause helical spring compression hangers except it shall incorporate a neoprene in shear element. The element moulded in special formulated rubber compound shall be resistant to oil, sunlight, corrosion and ozone.

Hangers shall be colour coded for identification

3207009 Plant bases

Steel equipment bases
Steel frame equipment bases shall comprise an all welded steel framework of sufficient rigidity to provide adequate support for the equipment and adequately stiff to prevent resonances at operating frequencies of the supported equipment. Cross framing shall be incorporated to provide adequate strength and stiffness. The steel frame base shall incorporate isolator mounting brackets and supported by spring isolator mounts appropriate to the plant type and the standard of isolation required.

The frame depth shall be approximately 1/10 of the longest dimension of the supported equipment, with a minimum of 150 mm.

Concrete inertia bases with steel springs
Concrete bases shall be formed from an all welded steel pouring framework and a frame depth of approximately 1/12 of the longest dimension of the base, with a minimum of 150 mm and no greater than 300 mm.

The bottom of the frame shall be blanked off and concrete (2300 kg/m^3 unless otherwise stated) poured in over the steel reinforcing bars. The reinforcing shall consist of 13 mm diameter bars welded on 150 mm centres running cross-batch positioned 35 mm above the bottom of the base or as specified by the Structural Engineer

The inertia base shall be sufficiently large to provide support for all parts of the equipment base, including any components which overhang the equipment base such as suction and discharge elbows on centrifugal pumps.

Unless stated otherwise, the weight of the base shall be twice that of the supported equipment.

All equipment must be rigidly coupled together as one mass on a single platform.

The vertical distance to the combined centre of mass from the top of the spring mounts must be less than horizontal distance.

The base shall incorporate plated steel ‘outrigger’ mounting brackets and supported by spring isolator mounts appropriate to the plant type, load and the standard of isolation required.

Alternative constructions shall be submitted to the CA prior to commencement of the Works.

Concrete inertia bases with neoprene pads/mounts
The inertia base shall be sufficiently large to provide support for all parts of the equipment base, including any components which overhang the equipment base such as suction and discharge elbows on centrifugal pumps.

The inertia base should be cast onto a permanent bottom shuttering, and supported on the specified neoprene mounts or pads, the whole resting on a plinth as required.

The construction of concrete bases on cork, expanded polystyrene or mineral wool slabs shall not be permitted.

Where neoprene pads are used, small areas of pad must be equally spaced to provide the required static deflection. The quantities, dimensions and locations of such pads shall be advised by the supplier and confirmed to the CA prior to commencement of the Works.

Neoprene pads / mounts shall not be used for external applications or areas within direct sunlight.

3207010 Pipework flexible connections

Flexible pipe compensators shall be installed on pipe connections to all rotating or reciprocating plant isolated by vibration control equipment.

Construction
Type: single convolution rubber bellows
Liner: EDPM rubber
Reinforcement: steel wire mesh reinforced throughout and manufactured in accordance with DIN 4809
Cover: EDPM rubber
Flanges: Carbon steel to BS EN 1092 and shall be able to swivel and be removable
Threaded ends: BS 21 with one union end
Tie bars: Carbon steel zinc plated adjustable tie bar assembly

The units shall be suitable for the working pressure and temperature.

All units shall have an indelible identification indicating manufacturer, date of manufacture, type, size, pressure rating and be colour coded.

The units shall have a design life of 10 years at 100 °C. Units shall be in accordance with DIN 4809 and after a service life of 10 years at 100 °C must have a burst pressure of not less than 30 bar.

Where untied bellows are used the manufacturer's recommendations for anchors and guides shall be followed.

Tie bars shall be threaded and with adjustable length. Tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar.

Ensure flexible connections are tied when the plant is on vibration isolation mountings.

The installer shall ensure that the flexible pipe connections proposed are capable of withstanding the system operating temperatures and pressures.

3207011 Ductwork flexible connections

Ductwork connected to rotating or reciprocating equipment shall be isolated by means of flexible connections including all inlets and outlets of axial flow fans, centrifugal cased fans and air handling units (if fans in units are not anti-vibration mounted).

Flexible connections shall be inherently non-combustible and limit the surface spread of flame to Class 1 when tested in accordance with BS 476: Part 7 and shall not emit toxic or hazardous fumes if ignited

Flexible connections shall prevent all transmission of vibration and be in accordance with DW 144 and DW 151 as appropriate.

The material must withstand the specified conditions of temperature, noise attenuation and air pressure.

The minimum distance between duct ends shall not be less than 50mm with a maximum dimension of 250mm. The flexible connection shall not restrict airflow within the ductwork system, nor should the joint be used to correct x and y alignment of the ducts either side.

On rectangular connections, the material shall be held in place by a mating flange with a backing plate.

Flexible connections to circular ducting on fan inlet spigots shall be secured by clip band fasteners having adjustable screws or toggle fittings.

The material is to be fitted to give a tightly clamped joint with no air gaps, the connection remaining flexible without strain and distortion, and shall be correctly aligned.

The flexible material and the joints shall comply with the standard of airtightness specified for the ductwork system of which it forms part.

Flexible connections shall not be painted.

3207012 Acoustic testing

Unless otherwise stated, sound pressure levels shall be measured in all spaces containing supply or extract terminals, all plantrooms, all rooms immediately adjacent to plantrooms and all rooms located above or below plantrooms.

The results shall incorporate a spectrum band analysis made at octave band centre frequencies from 63 Hz to 8k Hz. Results shall be both tabulated and plotted on NR curves.

All plant such as fans, chillers, pumps, boilers etc shall be tested to ensure their acoustic performance is within the respective manufacturer's stated data at the time of order and results submitted to the CA.

Noise readings shall be taken at the site boundaries and adjacent to facades to demonstrate the acoustic performance of the systems (at full load) complies with the noise levels stated elsewhere.

Locations for noise readings shall be agreed with the CA prior to measurements being undertaken.

Measuring of environmental noise shall be in accordance with BS 4142 and the local authority guidelines.

All measurements undertaken to demonstrate compliance with the specification shall be performed using sound measuring equipment conforming to BS EN 61672 and other relevant standards. Calibration certification for all measuring equipment shall be submitted to the CA prior to measurements being undertaken.

Duplicate records of all such shall be provided to the CA within 3 days of testing and copies included in the operating and maintenance documentation. All records shall be signed by a competent person and witnessed. Results shall be submitted to the CA for examination before any system is offered for final acceptance.

Any witnessing or independent checking by the CA shall be carried out solely at the discretion of the CA as considered necessary.

All necessary apparatus, measuring equipment, instruments, and meters required for acoustic testing of the Works shall be provided by the installer at no additional cost.

3208000 INSTRUMENTATION AND METERING

3208001 Water temperature gauges/thermometers

Water temperature gauges/thermometers shall be installed at the following positions in addition to any other particular position stated elsewhere or indicated on the drawings:

- On flow and return connections to heating and chilled water coils except on individual fan coil units and induction type terminal units.
- On flow and return chilled and condenser water connections to water chillers.
- On the inlet and discharge connections to cooling towers.
- On the cold feed connection to the HWS cylinders.
- On the main HWS secondary flow and return connections to HWS cylinders.
- On the flow and return connections to each heating boiler.
- On the main common flow header from the water chillers and heating boilers.
- On the primary flow and return connections to each HWS cylinder.
- On branch return connections to the main return chilled water and heating headers.
- On the flue connection to each boiler.

Temperature gauges/thermometers shall be 100 mm diameter gas filled type acting through mechanical linkage to BS EN 13190 with matt black case and polished chrome bezel, horizontal or vertical rigid stem to suit the particular application, black indicating pointer with red hand set and graduated in °C with the range equal to twice the normal operating temperature. The accuracy of thermometers shall be ± 1% of the full scale reading.

Where gauges are externally located they shall be of weather resistant construction.

3208002 Pressure/altitude gauges

Pressure gauges and gauge cocks shall be fitted to indicate system pressures/heads at the following positions in addition to any other particular position stated elsewhere or indicated on the drawings:

- On chilled water connections to each water chiller.
- On condenser water connections to each water chiller.
- Pressure differential gauges across the suction and discharge connection of every circulating pump.
- On the discharge of every spray pump.
- On flow connections to cooling towers.
- On the primary heating connections to the HWS cylinders.
- On the inlet and outlet connection to pressure reducing valves.
- On the inlet and outlet connections to strainers (32 mm and above).

Each pressure/altitude gauge shall be 100 mm diameter and of the bourdon tube operation type to BS EN 837-1 with red hand set and black indicating pointers, removable front glass face, matt black case and polished chrome bezel, scale graduated in kPa to twice the pressure range covered with normal indication mid-point of scale.

The pressure/altitude gauges shall be complete with the correct size of pocket and gunmetal gauge cock with ebony handle. The accuracy of the gauges shall be ± 1% of the scale range.

Where gauges are externally located they shall be of weather resistant construction

3208003 Temperature and pressure test points

Self-sealing test plugs shall be fitted where indicated on the drawings and in addition the positions listed below or as stated elsewhere. The plugs shall be fitted in to screwed bosses welded into the pipeline at bends or other locations to ensure full penetration of the gauge probe and shall be suitably rated for each application.

The test points shall be of gun metal construction and shall have long life ethylene-propylene diaphragms and be complete with a screwed sealing cap, retaining strap and renewable washer.

Two insertion pressure gauges and two thermometers shall be provided for each range of conditions. Pressure gauges shall be of the 60 mm diameter bourden tube type (complete with twinlock adaptor) and thermometer gauges shall be of the 45 mm diameter bi-metallic type.

Test plugs shall be installed at the following positions in addition to any other particular position stated elsewhere or indicated on the drawings:

- On the flow and return connections to each terminal heat transfer unit.
- On each port of every automatic valve.
- On flow and return connections to each heating and cooling coil.
- On the suction and discharge of each circulating or transfer pump.
- On the inlet and outlet connections to strainers (32 mm and below).
- On the flow and return of each branch line.

3208004 Digital Temperature Meter

Provide in a suitable protective container for handing to the Employer a digital battery operated thermometer and interchangeable plug and socket sensing probe to suit test points.

3303000 PUMPS AND PRESSURISATION

3303001 General requirements

All pumps shall be selected to deliver the design flow rate at the design head resistance plus 10%

All pumps shall be suitable for the service pumped and the operating temperatures and pressures.

Pumps shall be capable of providing the duties required at the design operating conditions.

The installer shall recalculate the total system resistance based upon the final plant selection and installed drawings and revise the pump duty as necessary to achieve the design flow rate.

The installer shall similarly reselect the necessary electrical requirements or any other variation in associated equipment caused by a change in system pressure drop.

Provide pumps manufactured and tested in accordance with appropriate British Standards, in particular BS EN 809, BS EN 60335-2-41, BS EN 60335-2-51:2003+A1:2008, BS EN ISO 5198, BS EN ISO 9906, BS 5257 and BS 4082 where applicable

Performance curves showing head, volume flow rate, efficiency and absorbed power of each pump shall be submitted to the CA prior to equipment being ordered. Pump curves shall indicate performance under all likely operating conditions. Pump test data shall comply with BS EN ISO 9906 and BS EN ISO 5198. Data shall be related to pump speed to allow the effect of speed changes to be assessed.

Pumps shall be selected to ensure that they are not operating at the extremes of their range by basing the selection on a mid-range impeller. Select pump at or near most efficient part of performance curve for duty required.

All pumps shall have the motor, motor frame, impeller casing and drives of sufficient size to allow the capability of a 10% minimum increase in head generated at the stated flow rate by increasing the impeller size only.

Connecting pipework shall be arranged to ensure that no stresses are transmitted to the pump casings.

Pumps shall be provided with anti-vibration mountings and flexible connections. The installer shall ensure that the complete unit is effectively balanced to eliminate noise and vibration.

Pumps shall be arranged to be fully accessible for maintenance with adequate space to allow motors to be safely removed from the pump assembly and for lifting equipment if required.

Single case twin impeller/twin motor pumps shall be provided with a blanking plate to allow one pump to continue operating while the motor of the other is removed.

Unless otherwise stated pumps shall have a maximum sound pressure level of 75 dBA at a distance of 1 metre

Minimum pumping efficiency shall be 70% at the design duty.

Pumps on closed circuit systems shall be selected with a maximum operating speed of 1450 rpm unless otherwise stated or agreed with the CA.

Motors shall comply with the relevant sections of this specification. All motor selections shall be agreed with the CA prior to the equipment being ordered.

Where stand-by pumps are indicated with automatic change-over, the change-over shall be initiated and verified by means of flow sensing devices of an approved type. Non-return check valves, selected to have low resistance flow, shall be incorporated in each discharge line.

Pumps shall not be used for flushing and cleaning of the systems. Temporary pumps are to be used.

Each pump shall be fitted with an isolating valve on the inlet and outlet connections. Valves and strainers shall be pipeline size, not connection size and shall be in accordance with the relevant sections of this specification.

Pump connections shall be provided with flanges or unions, as appropriate, to permit the pipework to be removed for casing and impeller inspection and cleaning without draining the system or major dismantling of pipework.

Pump connections shall be screwed to BS 21, BS EN 10226-1 and BS EN 10226 for sizes up to 50 mm diameter and flanged to BS EN 1092 to suit the system maximum pressure on sizes 65 mm and above.

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

Bedplates, incorporating drain pans shall have a piped drain arranged to discharge over a protected tundish.

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

Locate pumps with adequate space to facilitate maintenance and future replacement in a safe manner.

Comply with manufacturer's recommendations for installation of pumps.

For in-line pumps ensure that motor is positioned in accordance with the manufacturer's requirements.

Support pumps independently from connecting pipework to ensure no load is transmitted from pipework to the pump casing on pump suction and discharge.

Align the pumps to prevent undue restraint and thrust on interconnecting pipework. Align drives to prevent undue wear and restraint on pump shaft. For belt drives, align pulleys and tension belts to prevent undue wear and out of balance forces.

3303002 Gauges

Each pump shall be provided with two pressure gauges, one connected to the suction side and one to the discharge side. Gauges to be selected so that the gauge reads in the mid-range when operating at the design criteria.

Where stand-by pumps are installed, one pair of gauges shall be so connected with isolating cocks that the pressure head of each pump can be read.

3303003 Guards

All power transmission shafts, belts and pulley drives shall be guarded and be in compliance with PD 5304.

Guards shall be installed to prevent inadvertent contact with dangerous parts of machinery and the mesh size and/or the location of the guard shall prevent finger contact with any enclosed danger point.

Construction and installation shall ensure strength and rigidity and it shall not be possible to remove any guard or access panel without the aid of a tool.

Where required removable access panels shall be provided to permit tachometer readings to be made of motor and drive shafts and belt tension to be tested.

3303004 Belt drives

Belt drives shall comply with BS 3790. A minimum of two belts shall be provided and the drive sized so that the rated power output of the motor can be transmitted with one belt removed. Belts shall be of rubber and fibre V section unless otherwise indicated.

Provision for positive adjustment of belt tension and alignment shall be made.

Pulleys shall be correctly aligned in accordance with the manufacturer's requirements.

3303005 Centrifugal pumps

Pumps shall be provided with cast iron casings.

Shafts shall be stainless steel and impellers shall be manufactured from high grade gunmetal or bronze as indicated. Shafts shall be corrosion resistant.

Shaft seals shall be the drip-less mechanical type suitable for the operating conditions.

Direct drive pumps and their drive motors shall be mounted on a common bed-plate.

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

Close-coupled pumps shall be arranged such that the failure of a pump seal shall not result in damage to the drive motor.

Belt driven pumps shall be of the overhead compact type, comprising vertical split case design pump pedestal, driven, via ‘vee’ belts, by a motor mounted vertically above the pump.

Belt driven pumps shall incorporate an isolation pad within the motor mounting arrangement to minimize the transmission of vibration to the pump casing.

Pumps shall be suitable for mounting on a prepared base, being either concrete or inertia type where indicated.

3303006 Twin pump sets

Twin pump sets shall comprise direct in-line pumps connected in parallel with common inlet and outlet connections.

The assembly shall incorporate non-return check valves to isolate the stationary pump.

Twin pump sets shall be suitable for mounting on a prepared base or on wall brackets as indicated.
Impeller and motor assemblies shall be readily removable and a blanking flange shall be provided.

3303007 Glandless pumps

Canned rotor and glandless pumps up to 2 kW input power shall comply with BS EN 60335-2-51:2003+A1:2008

3303008 Sump pumps

Submersible sump pumps shall be provided with fully waterproof motors suitable for the application and to the correct IP rating.

Pumps shall be provided with flexible electrical harness capable of permitting withdrawal from the sump. Each pump shall be complete with a chain and guide rails to enable withdrawal.

Each pump shall be protected by a removable non-ferrous strainer on the suction.

Suction lift pumps shall terminate with a foot valve of diameter not less than the pipework. A non-return valve shall be provided on each pump discharge.

Duplicate pumps shall be provided with isolation valves on each pump discharge. Level controls shall be staggered to run the pumps as duty and support. Lead pump changeover facilities shall be provided.

Sump pumps shall operate automatically under level control and high and low level controllers shall be provided. A high level alarm to indicate when normal high water level is exceeded shall also be provided.

A locally mounted control panel with on/off/hand/auto control, starter, and isolator shall be provided. Facilities for remote monitoring shall be provided as indicated.

Studs, bolts, nuts, screws and washers shall be stainless steel

3303009 Semi rotary hand pumps

Semi rotary hand pumps shall be manufactured from materials suitable for the particular requirements.

Pumps shall have a foot valve and strainer and be fixed securely in position to allow for ease of manual operation.
Pumps for boiler rooms and plant room drainage shall be suitable for use with hot water at temperatures up to 98°C.

For drainage of oil storage catch-pits, shaft seals of the ‘O’ ring pattern shall be used.

A non-return valve and isolating valve shall be provided on the pump discharge.

3303010 Oil circulating and oil transfer pumps

Oil pumps shall be electrically driven positive displacement screw or gear type or of the centrifugal type, suitable for the viscosity and temperature of the grade of oil to be pumped as stated elsewhere. An integral pressure relief valve shall be fitted to positive displacement pumps.

Pumps for transferring oil from a bulk storage tank shall be started manually and switched off automatically by means of a float switch fitted in the service tank unless otherwise stated.

3303011 Closed system pressurisation units

Closed system pressurisation units shall be complete package units containing expansion vessel(s), pumps, break tank and all controls, interlocks and ancillary equipment necessary to maintain the system operating conditions.

The whole unit shall be factory wired and shall be controlled via an integral control panel. Where required all ferrous metal shall be factory primed and gloss painted on site to an approved colour.

Expansion vessels shall be in accordance with BS EN 13831. Vessels shall be all welded steel construction and contain a removable butyl rubber sac or diaphragm enclosing a permanent pre-charged air cushion.

Each unit shall be provided with sufficient number and capacity of expansion vessels. These shall handle the full expansion volume of the system from normal cold fill or ambient conditions to normal working temperature.

Vessels shall have provision to clean rubber sacs.

The actual system water contents and the capacity of the pressure vessel and break tank shall be calculated by the installer to achieve and accept the total system contraction/expansion volume of water. For heating and critical cooling systems two vessels shall be supplied both capable of occupying the total contraction/expansion volume of water unless stated otherwise.

The system pressure shall be maintained with the pressurisation pump operating for only 20% of the total operating hours and the vessels shall be sized to prevent over frequent operation of the pump.

The integral break tank shall be manufactured from GRP and be complete with a removable lid, ball valve inlet, overflow connection with discharge pipe, drain cock and outlet connection to the pump. The ball valve inlet shall comply with Water Supply Regulations.

Duplicate direct-coupled pumps shall be provided comprising cast iron casing with gunmetal impeller, stainless steel shaft, motor, mountings and fittings or as otherwise indicated.

Pumps shall be complete with drain plug, isolating valves and neoprene/rubber flexible compensators. Pressure test points shall be provided on the suction and discharge connections.

Automatic changeover of the pumps shall be provided on pump failure. The changeover shall be remotely indicated. Provision shall be incorporated for periodic variation of the duty pump. Each pump shall be fitted with an ‘hours run’ counter. The over frequent starting of the duty pump shall be indicated.

High and low level pressure switches shall be provided for pump control. Separate high and low pressure switches shall be provided to interlock and shut off the boiler or chiller plant if the system operating limits are exceeded. The switches shall be hand reset. A low-level alarm shall be provided on the break tank to stop the pump-set if the water level in the tank drops to a dangerous level.

Facilities for the transmission of the status of pumps, operating pressures and alarms from the unit to the main control panel or building management system, as indicated, shall be provided.

A safety valve shall be provided on closed systems with expansion vessels wherever required by BS 7074.

For initial system filling, a proprietary flexible hose system, complete with water stop valve, backflow prevention devices, braided hose, isolating valves, strainer etc shall be provided and comply with Water Supply Regulations. Suitable wall mounted racking shall be provided to store the hose filling equipment.

A surge prevention valve shall be installed on the delivery side of all booster sets to prevent pressure surges in the supply main following drain down.

3303012 Cold water booster set

Cold water booster sets shall be self-contained, fully automatic packaged units capable of the required duty and pressure as stated elsewhere. Each unit shall be supplied assembled and tested as a complete unit and suitable for the ambient operating conditions.

Hydraulic and performance test data shall be submitted to the CA prior to dispatch from the manufacturer's works.

Equipment, fittings, jointing, valves etc in contact with water shall be approved by the WRAS for the application and listed in the current edition of the 'Water fittings and materials directory'. Equipment not complying shall be rejected and replaced at no cost to the contract.

The set shall be complete with jockey, duty, support and standby pumps to meet the duty as indicated. Unless otherwise stated the unit shall have a maximum sound pressure level of 70 dBA at a distance of 1 metre. Pumps, motors and drives shall comply with the appropriate clauses of the specification.

Pumps shall be multi-stage type with mechanical seals, cast iron bodies, stainless steel shafts and impellers. Pumps shall be capable of providing the required performance indicated with a minimum efficiency of 66%.

The unit shall be provided with a membrane pressure vessel that is sized to maintain the required system duty while limiting the number of starts by the duty pump to a maximum of 15 per hour unless indicated otherwise. Pressure vessels shall be constructed of mild steel and shall be fitted with an internal diaphragm on non-toxic material capable of holding the entire water contents of the vessel. The unit shall be capable of withstanding a minimum working pressure of 10 bar or 1.5 times the working pressure whichever is the greater unless otherwise indicated.

An automatic control panel with hinged access door, mains isolator and controls for operation and safety protection shall be provided as part of the unit. The panel shall include facilities for the transmission of plant status to the main control panel or BMS. Visual LED display and monitoring shall include low water level, pump run and tripped status, system pressure and fault alarms..

The panel shall include the following features:

1. Hand/off/auto switch for each pump
2. Low water cut out alarm
3. Auto rotation of duty pump
4. Auto pump change over
5. Door interlocked isolator
6. Adjustable run and start delays
7. 'Hours run' counter for each pump

A low level alarm shall be provided in the incoming break tank, together with a low pressure switch on the incoming water pipework to prevent the unit from operating with low inlet water conditions.

Each unit shall be complete with interconnecting pipework, flexible connectors, non-return valves and isolating valves. Pipework shall be copper tube with non-de-zincifiable fittings unless indicated otherwise.

The unit shall be mounted on a single galvanised steel base and shall incorporate anti-vibration provision to prevent the transmission of noise or vibration to the structure or connecting pipework. Where required all ferrous metal shall be factory primed and gloss painted on site to an approved colour.

Section 5000000 – Building management system and automatic controls

5201000 BMS/AUTOMATIC CONTROLS – WORKMANSHIP AND MATERIALS

5201001 Standards

The controls system shall comply with the following EC Directives:

1. Low voltage Directive 73/23/EEC and amendments 93/68/EEC
2. Construction Products Directive 89/106/EEC
3. General Product Safety Directive 92/59/EEC

Ensure that the controls system/BMS installation complies with BS 7671.

Control panels shall comply with BS EN 60439-1 and BS EN 61439 -2 Low voltage switchgear and control assemblies.

Ensure that the controls system/BMS installation can operate with the electricity supply.

Ensure that the controls system/BMS installation complies with:

1. The Electromagnetic Compatibility Regulations 2005 (SI 2005/281).
2. BS EN 61000-6-1 Electromagnetic Compatibility (EMC).Generic standards. Immunity for residential, commercial and light industrial environments
3. BS EN 61000-6-2 Electromagnetic Compatibility (EMC).Generic standards. Immunity standard for industrial environments.
4. BS EN 61000-6-3 Electromagnetic Compatibility (EMC).Generic emission standards. Emission standard for residential, commercial and light industrial environments.

5201002 Control panels

General

All grouped controls shall be enclosed in a purpose-made panel. Motor starters and controllers for mounting in the panel shall comply with BS EN 60947. Panels shall provide the BS EN 60947 degree of protection indicated.

Purpose-made panels shall comply with the requirements for assemblies contained in BS EN 61439 and BS EN 61439 -2

Control panels shall be manufactured, equipped, wired and tested by the manufacturer at works before delivery to site.

Unless otherwise indicated 15% spare back-plate capacity shall be provided. The power distribution system within panels shall be sized to allow additional switchgear to suit the spare capacity provision.

All control panels providing electrical supplies to or control of mechanical services plant and equipment shall be constructed to comply with the latest relevant statutes, regulations and standards.

Clean schematic diagrams shall be provided, contained in a plastic pocket fixed permanently within each door or within purpose made housing.

Indicating lamps, instruments and controls shall be, as far as is practicable, of the same manufacturer and style to provide uniformity of appearance and to facilitate maintenance.

Externally visible equipment shall be flush mounted with minimum projection and fixed securely to the front of panels.

Construction

Panels shall be designed to be wall mounted (with external fixing lugs) or floor standing as appropriate and shall be constructed from galvanised steel plate of not less than 2mm thickness.

Detachable gasketted gland plates for cable/wiring entry shall be provided on all appropriate elevations.

Surfaces shall be properly prepared before final finishing. All sections of the control panel shall, prior to assembly, be degreased and chromate etched followed by two coats of primer before being stove enamelled. The panel external colour shall be as agreed with the CA prior to manufacturer.

Finished panels shall be without sharp edges and exposed fastenings smooth surfaced. All exposed screws, bolts and similar fastenings shall be protectively plated.

Panels shall be adequately protected against damage or deterioration during and after delivery and installation on site until practical completion. Cleaning, making-good and re-spraying shall be carried out at no cost to the contract.

The maximum height shall be 2200mm, unless otherwise indicated.

Panels wider than 1600mm shall be manufactured in sections unless otherwise indicated. Each section shall be supplied with fully numbered interconnecting terminals. Sections shall be bolted and wired together on site after positioning.

Unless otherwise indicated the doors shall be 800mm maximum in width and shall be fitted with concealed hinges to facilitate the removal of the door panel if required.

A minimum of two doors are to be provided on any panels wider than 800mm. Doors shall be complete with dust excluding gaskets around their perimeter.

Doors shall be secured by integral handle with provision for locking, such provision being not more 2 metres above floor level. One key shall fit all locks provided on all panels delivered to the site.

Panels shall be located so that full and safe access is obtained to itself, other apparatus, terminals and interconnecting wiring.

Panels shall be drip-proof, dust-proof and vermin proof with a minimum standard of protection to IP54 for internal units or IP65 for externally mounted panels unless otherwise indicated.

The temperature rise in motor control panels shall not exceed the limits stated in BS EN 61439. Control panels shall be adequately ventilated and temperature controlled to maintain the internal operating conditions to ensure satisfactory operation of all panel mounted equipment. As necessary internal forced cooling, ventilation grilles, internal anti-condensation heaters and thermostats shall be provided.

Internal lighting and external lap-top shelves shall be provided as appropriate.

Insulating rubber matting of the appropriate voltage grade shall be provided and extend the full length of the control panel at the front and where, accessible, at the rear.

Panels not mounted on concrete plinths shall be provided with a purpose made steel plinth to match the panel. Plinths shall be a minimum of 100mm high unless otherwise indicated.

All panels shall be provided with fixing holes. Large panels or panels exceeding 50kg shall be provided with detachable lifting eyes.

A power outlet shall be provided inside the panel complete with 30 mA RCD protection.

Equipment shall be shrouded as necessary to prevent accidental contact with live parts.

Form 2 panels shall comprise compartment assemblies complying with BEAMA Installation recommendations for Form 2, type 2 of BS EN 61439. They shall be provided with a physical vertical delineation between the power section and the BMS/controls section.

Equipment, busbars and wiring shall be either totally enclosed or protected as required by BS EN 61439-6for the class of panel.

Form 4 panels shall be a CE marked, ASTA certified, multi-cubicle, type-tested assembly (TTA) to BS EN 61439-1 with Form 4 segregation in accordance with BEAMA Installation recommendations. They shall be constructed to ensure separation of busbars from all functional units and separation of all functional units from one another. Separation of terminals for external conductors associated with a functional unit from those of any other functional unit and the busbars

Electrical isolation
All control panels shall be provided with a door interlock isolator controlling the main incoming supply. The isolator shall be capable of making and breaking on full load without damage. Additionally the isolator shall be equipped with auxiliary contacts to isolate any secondary supplies to the control panel.

All terminals of the isolator (incoming and outgoing) are to be shrouded to prevent accidental contact.

As indicated the control system only shall be energised whilst the incoming supplies are isolated. A suitable by-pass fuse shall be fitted with the necessary shrouding and identification.

The panel shall be constructed such that power (400/230V) equipment is located behind the interlocked isolator door.

Control (extra low voltage) equipment shall be located within a separate section to ensure segregation from power equipment.

Control panel wiring
Internal power wiring shall be identified by colour code in accordance with BS 7671. Control circuit and other wiring shall be to BS 6231.

All cables shall be colour coded and numbered using a proprietary marking system comprising plastic ferrules of the correct size for the cable. Cables shall be identified at both ends and shall be cross-referenced with the wiring diagram.

All terminals shall be permanently identified by colour coded inserts with black lettering and shall be cross-referenced with the panel wiring diagram.

Power and control cables shall be terminated using crimp type connectors or other approved termination devices. Soldered terminations will not be accepted.

Low voltage power and extra low voltage wiring shall be segregated throughout the panel.

Provision shall be made for the earthing of all non-current carrying panel and equipment metalwork including panel door(s). All necessary electrical bonding shall be provided. A copper earth bar rated for the panel fault current shall be provided for connection of the incoming earth and the field power circuit protective conductors. Access shall be provided for making connections to the earthing system.

All internal wiring shall be enclosed within wire-ways. Inter wiring that is required to pass between the power and control sections of the panel shall be enclosed within separate or segregated wire-ways to ensure electrical separation of the power and control systems.

Individual terminals shall be provided for each connection entering or leaving the panel and shall be sized with regard to the type and size of cable taking into account the maximum circuit loading and length (volt drop).

Terminals for power and control wiring shall be located within their respective panel sections, where applicable.

Separate terminals shall be provided for the connection of the screening of screened or shielded cables.

No external wiring will be permitted to extend beyond the incoming/outgoing terminals of the panel, except those cables which are terminating directly onto BMS outstation devices.

Looms shall be limited in size to permit tracing, identification and replacement of faulty cables.

Busbars where installed, shall be rated to withstand, at any position the full fault level related to the largest protective fuse that could be used with the main panel isolator. They shall be fully insulated throughout their length and shall be mounted within a separate labelled enclosure within the panel.

Internal equipment
A technical summary identifying makes of generic components to be mounted in or on control panels shall be submitted to the CA for comment prior to manufacturer.

No equipment shall be incorporated into a control panel unless it conforms to the requirements of the relevant British Standard(s) or carrying the appropriate ASTA BEAB approved mark or other approved testing standard certificate.

Equipment shall be positioned within the panels to provide a neat and orderly arrangement. Equipment shall not be fixed to openable doors.

Internal equipment shall be fixed to purpose-made rails or mounting bars. All fixings shall incorporate shake-proof washers or other vibration resisting fastenings.

All starters, relays etc. shall be of the open type and shall be suitable for DIN rail mounting.

All outgoing power supplies to remote equipment shall be individually protected by HRC fuses or MCB's as indicated.

Fuses/MCBs shall be grouped and mounted so as to be readily accessible without danger.

All fuses and MCB's shall be identified on a permanently marked fuse chart mounted inside the panel.

Unless otherwise indicated a minimum of 3 spare fuses for each size and type used shall be mounted in a suitable carrier within the panel.

Where short circuit ratings are specified documentary evidence of compliance with such requirements shall be provided.

Overload settings shall be set to suit the load served and the settings recorded in the record documents.

Motor starters and speed control
All starters shall be by the same manufacturer.

Starters shall incorporate overload and single-phase protection and auxiliary contacts as required. Starters shall comply with BS EN 60947-4-1 and incorporate overload protection devices complete with manual reset buttons. Reset buttons shall be fully accessible without removing the starter cover

Unless otherwise stated starting methods shall be as follows:

1. Up to and including 5kW — Variable speed drive (where possible) or direct-on-line
2. Over 5kW — Variable speed drive

The controls specialist shall consult the manufacturer where necessary to ensure the correct overload protection.

Starters shall also comply with the specific requirements detailed elsewhere.

Starters shall be of open type for mounting in common cupboard type enclosure with one main supply isolator for the complete panel, unless otherwise stated.

Any limitation on starting currents, as might be imposed by the Supply Authority, shall be complied with. Where the indicated starting methods do not satisfy the limitations, a suitable alternative starter shall be provided as agreed with the CA prior to commencement of the Works.

Variable speed drives shall be installed as specified elsewhere in this specification

Automatic control
For the control of electrical equipment which is not interlocked, an 'ON/OFF' rotary type switch shall be fitted on the front of the panel for each item of plant.

Where interlocks are required an 'ON/OFF' switch shall be fitted for the master and a 'HAND/ OFF/AUTO' switch shall be fitted for each item of dependent plant. The switch positions shall be clearly indicated and each switch shall be clearly labelled to show which item of plant it controls.

Duty/standby plant shall have individual 'HAND/ OFF/AUTO' switches but shall be interlocked to prevent both items of plant running together.

Control relays shall be of the transistorised plug-in type, with test facility and indication, robust in construction and mounted on a terminal base with the number of contacts commensurate with the duty they are to perform.

Indicator lamps
Single lamps shall be of the transformer lamp type or LED type as indicated.

Neon indicators will not be permitted.

Indicating lamps shall generally conform to the following colour code:

Colour	Operating status
Red	Trip or fault
Yellow(Amber)	Alarm / Attention / Caution
Green	Equipment running
White(clear)	Power available / Condition healthy
Blue	Closed

Lamps and holders shall be arranged so that replacement of lamps and cleaning of lenses can be easily effected.

Where indicator lamps are not immediately adjacent to their associated switches they shall be clearly labeled.

A lamp test facility shall be provided on all panels.

The following shall be provided:

1. Red/yellow/blue phase healthy indication
2. Panel control circuit healthy indication
3. Field control circuit healthy indication

Identification and labeling
Wiring shall be adequately colour coded and numbered and indicated on the schematic wiring diagrams and schedules, using a proprietary cable marking system comprising permanently fixed plastic ferrules of the correct size for the cable.

All terminals shall be adequately numbered, as indicated on the schematic wiring diagrams. Hand written numbering shall not be accepted.

All items of internal panel equipment shall be readily identified with clearly visible labels. Such labeling shall correspond in detail with the panel wiring diagrams.

All labels shall be engraved on traffolyte or similar engraving laminate and shall be fixed by means of 3mm chrome screws or plastic rivets. Unless otherwise indicated black lettering on white background shall be provided. Warning labels shall have red lettering on a yellow background. Details of engraved labels shall be provided to the CA for approval prior to manufacture.

All panels and individual panel sections shall be provided with exterior labels to BS 5499-5 indicating the voltage within the panel and clear warnings of risk and instructions for isolation.

All switches, controls and indicators on control panels shall be labeled as to function and associated plant.

Local interfaces

Where indicated control panels shall have a fascia mounted keypad and display for local interrogation, set point alteration and command execution. It shall be possible to communicate with the entire network from the unit.

Where indicated control panels shall have a fascia mounted socket to allow local interrogation, set point alteration, and command execution via a portable computer or palm top device.

It shall be possible to communicate with all the controllers located within the associated control panel. As indicated the Controls Specialist shall provide the portable computer or palm top device, all necessary software, software licences, and peripheral equipment.

Control panel testing

Control panels shall be fully equipped, wired and tested before delivery to site.

Unless otherwise indicated the following tests and inspections shall be undertaken at the manufacturer's works in the presence of the CA. The control panel manufacturer shall provide written evidence for the following points, including appropriate certification, that the panel has been tested in accordance with the specification prior to inspection by the CA.

1. Functional testing including simulation of operation, sequencing, interlocking and automatic controls
2. Demonstrating time delays and protection relay setting
3. Checking all labelling, cable numbering etc and compliance with wiring diagrams and schematics
4. High voltage pressure test of 2kV followed by an insulation test
5. Demonstrating that all MCBs or fuses are of the correct type and rating
6. Testing of all transformers for correct polarity and ratio and protection relays for correct operation.
7. Demonstrating access to all equipment especially devices requiring adjustment.
8. Demonstrating access for all incoming cables and for outgoing power and control cables together with provision of suitable gland plates
9. Demonstrating compliance with the BS 7671
10. Demonstrating the provision to maintain the internal environment of the panel
11. Demonstrating sufficient spare capacity as required by the specification
12. Visual inspection, to include but not limited to:
13. Neatness and size of cable looms
14. Tightness of all connections, bolted power connections and bus-bar bolts tightened to the correct torque.
15. Segregation of power cabling and switchgear from control cabling and electronic equipment.
16. Shrouding of non-isolated equipment, switches, lamps etc
17. Panel metalwork and finish quality
18. Any other tests required by the CA.

The CA shall be given 10 working days written notice of all testing and inspections unless otherwise indicated.

Certified schedules detailing all tests and their results shall be submitted to the CA within 5 working days of the tests.

Adequate precautions shall be taken to ensure that it is protected from dirt, damage and moisture. Sensitive electronic components shall be removed and stored separately.

On completion of all field wiring to the power section the flash test shall be repeated followed by an insulation test. All isolators shall be closed and power fuses fitted. Control fuses and other low voltage equipment fuses shall be removed for the duration of the test to avoid damaging any extra-low voltage equipment. Flash tests shall be performed for mains powered equipment only.

Before the power is switched on, all new connections into the panel shall be checked and the interlocks re-checked before the plant is operated.

On completion of the installation, including all field wiring, a complete panel test and inspection shall be undertaken on-site in the presence of the CA. The tests and inspections shall be as undertaken at the manufacturer's works unless otherwise indicated.

5201003 Field Devices

General

A schedule of field devices shall be submitted to the CA, cross referenced to the points schedule and showing the total number and specification of the devices to be supplied. The information shall include manufacturer, model, range, accuracy, flow characteristics, working/operating and static pressure ranges.

Sensors shall be selected to have a suitable measuring range and IP rating for their required application.

Sensors shall be located to achieve representative and accurate readings of the controlled or monitored medium. The Controls Specialist shall be responsible for the correct output and positions for sensors. Where sensor positions are indicated the Controls Specialist shall advise any corrections to the CA at a very early stage of the project.

Sensors shall in all cases be installed in accordance with the manufacturer's instructions.

Sensors, detectors and associated meters shall have a proven record of precision and reliability when used with BMS and building services systems.

All devices shall be installed with adequate access and clearance to permit maintenance, testing and removal of any item. Inspection of all wiring connections shall be possible without removal of the component.

Each device shall be labelled and the location of concealed devices marked and recorded.

Where a device type is not stated the Controls Specialist shall submit data to the CA for approval.

Temperature Sensors

General

Temperature sensors shall comply with the following minimum requirements:

Fluid	Temperature range °C	Sensor accuracy °C
Air	-10 to +40	± 0.5
Flue gas	+30 to +850	± 3
Chilled water	-10 to +30	± 0.25
Water	-10 to +150	± 0.5

Where a fluid is not identified the error range shall be agreed with the CA.

Drift shall be less than 0.1K per year.

Thermistor sensors shall have a hysteresis error which shall not exceed 0.5%.

Temperature sensors shall be thermistor types unless otherwise indicated. Compensation for the non-linear characteristic shall be such that the accuracy at range ends shall not exceed ±5% and at the setpoint ±2%.

Sensor ranges shall be chosen so that the range extends to those which might be experienced under plant fault conditions.

Strap-on temperature sensors shall only be installed in applications as agreed with the CA.

Pipe mounted immersion sensor
The full active length of the sensor shall be immersed in water.

Allow adequate space so that sensors can be removed from their immersion pockets.

Immersion pockets shall be stainless steel and appropriate pressure rating. Pockets shall be free issued to the Installer for installation in positions as indicated by the controls specialist.

Immersion temperature sensors shall be installed into pockets with the facility for removal without disruption to the system(s). Immersion pockets shall be filled with a heat conducting compound

Unless otherwise indicated a Binder test point or an additional immersion pocket, adjacent to the sensor, shall be provided for test purposes

Sensors shall be positioned not less than 12 pipe diameters downstream from a point of mixing to take account of stratification.

Immersion sensors for air ducts
Sensors for air temperature in ductwork shall be located in positions to most effectively sense the measured condition.

The full active portion of the sensor probe shall be exposed to the air flow.

The active portion of the probe shall be located central to the airflow.

A test hole shall be provided adjacent to every sensor with plug when not in use.

Probe-type sensors shall not be used in areas where stratification can occur.

Sensors positioned near to coils shall be shielded against radiative heat transfer.

Return air duct sensors shall be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings.

Sensors shall be positioned in an area of representative air flow.

Sensors representing zone temperature should be offset to account for heat gains.

Sensors used for determining the dew-point shall be of material and construction suitable for use in moist air.

Capillary sensors with probes
The device head must be higher than the sensor probe

The sensor probe should be tilted downwards

The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed

The sensor element must always point downwards. The capillary should not form a U-shape

The capillary should not be bent too tightly (radius of bend > 50mm)

Frost protection thermostat
Shall be the capillary type and automatically reset unless otherwise indicated and shall be installed to monitor the full face of the associated heating coil.

A spare capillary loop of 20 cm to enable sensor testing outside the duct/unit

The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space

The capillary should be installed in the air flow, downstream of the first heating coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.

Averaging sensor *(ducts and air handling units)*
Allow a distance of at least 50 mm between any heat exchanger and the sensor

The entire length of an averaging sensor must be fully inside the air-duct

The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration

The sensor element shall be installed in the air flow, downstream of the eliminator plate when air washers are used for humidification

Room sensor
Unless otherwise indicated sensors shall be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.

A sensor shall be located in an area representative of the entire control zone and located away from heat sources.

Sensors shall not be located near air currents generated by diffusers or openable windows and not be exposed to direct solar radiation

External wall locations shall be avoided where possible. Insulated back-plates shall be provided for external wall locations.

Conduit entry points to the sensor wall box shall be sealed where there is a risk of air from another zone flowing over the sensor element.

Outdoor air temperature sensors
Sensors shall have protection to IP67 unless otherwise stated.

Shall be complete with a radiation shield.

Sensors shall not be located on facades affected by significant rising heat or facades which will be heated by solar radiation.

Sensors shall not be located under eaves, above windows, ventilation extracts or subject to wind influence.

Ensure accessibility for safe inspection and maintenance.

Humidity sensors
Humidity sensors shall be of good stability and have a humidity range of 10% - 90% with a sensor accuracy of ± 5% RH.

Drift shall not exceed 2.5% of the full range per year.

Humidity sensor/stat – duct location
The air velocity in the vicinity of the sensor shall not exceed 10 m/s.

Sensors shall not be located in areas where there is no air flow.

A test hole shall be provided downstream of each sensor, plugged off when not in use.

Sensors shall be positioned beyond the spray distance of humidifiers.

Humidity sensor/stat – room location
Unless otherwise indicated sensors shall be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from adjacent walls or directly adjacent to doors.

Sensors shall not be exposed to direct solar radiation or be located near heat sources and be protected from airborne contaminants.

Adjacent to the space dry-bulb temperature sensor unless otherwise indicated.

External wall locations shall be avoided except were unavoidable. Insulated back-plates shall be used for external wall locations.

Air pressure sensors
Unless otherwise stated air pressure sensors shall have a sensor accuracy of ±2% of the reading. Sensors shall be supplied complete with pressure connections and connecting tubes.

Pressure sensors for measuring air at pressures greater than 1 bar shall be rated to meet two times the maximum pressure and 1.5 - 2 times the working pressure.

DP sensors for measuring air at duct pressure shall have an accuracy of 1% and a resolution of 0.1%. The sensors shall be supplied complete with pressure connections and connecting tubes. Ensure a steadying zone upstream and downstream of the orifice plate/flow grid.

Differential pressure air switches
Differential pressure switches for fan proving and filter monitoring and sensors for VAV static pressure control shall be supplied complete with duct connections and PVC connecting tubes of suitable length. The range and hysteresis adjustments shall be concealed to prevent tampering. Error shall not exceed ± 2% of full range after 200ms with a hysteresis of less than 0.4% and repeatable within 0.25%.

Indoor air quality sensors
CO2 sensors shall have an accuracy of ±2% (indicated value).

Indoor air quality (mixed gas) sensors shall detect combinations of pollutant gases.

Duct mounted sensors shall be located in the return air duct from the space as close as possible to the room extract point(s).

Room mounted sensors shall be located in a representative location at 1.5 to 3 m above the floor unless otherwise indicated.

Flow velocity/flow rate sensors
Air velocity sensors shall comply with the following minimum requirements

Sensor	Sensor range	Sensor accuracy
Pitot static tube	3 to 80 m/s	±2% of reading
Thermo-electric anemometer	0 to 20 m/s	±3% of reading or ±0.1 m/s whichever is the greatest

Sensors shall be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity.

Averaging velocity sensors across the duct shall be used where the minimum separation distance from a flow disruption is not available. The flow grid shall be sized correctly for the duct dimensions.

Differential pressure switches (liquids)
Differential pressure switches for water applications shall be rated to meet 2 times the static pressure and/or 4 times the working pressure. All wetted parts shall be stainless steel and switch housing protection to IP67 standard. The range and hysteresis adjustments shall be concealed

to prevent tampering. The mechanical services installer shall install the differential pressure switches and connect suitable pressure pipes to service isolating cocks.

Error shall not exceed ± 2% of full range after 200ms with a hysteresis of less than 0.4% and repeatable within 0.25%.

Flow meters
Flow meters shall comply with the following minimum requirements:

Meter	Meter range	Meter accuracy
Fuel flow meter	0 to 10 Hz	3% of reading
Water flow meter	>5:1	2% of reading
Electricity meter	-	1.5% of reading

Meters shall be complete with suitable pulse contacts.

Thermostats
Error shall not exceed those stated below for a particular type, where a type is not identified the error shall be agreed with the CA.

Type	Error
Bimetallic	± 5% full range
Liquid expansion	± 5% full range
Vapour expansion	± 1.5% full range
Electronic	± 1% full range

Light level sensors
Outside light sensors shall have a range of 10-2000 lux with an output of 4-20mA and be mounted in an IP67 enclosure. The sensor shall be mounted in an open position not subject to shade.

5201004 Field controllers

General
Field controllers shall comprise distributed intelligence controllers including outstations, unitary controllers and terminal unit controllers.

All field controllers shall perform all control actions independently of the operator workstation. The units shall operate with the loss of shared data through the use of default values and final data reading before the loss of network communications.

Unless otherwise indicated construct field controller enclosures shall give the following minimum degree of protection in accordance with BS EN 60529:

1. Internal plant room applications IP54.
2. External applications IP65.
3. Where located inside a control panel protected to IP54 the controller protection shall be IP41.

Controllers shall be modular construction and designed to allow the removal and replacement of devices without the need for rewiring of field wiring. Enclosures shall be lockable.

Unless otherwise indicated include provision for a future 20% increase.

Terminals shall be the screw down clamp-type fixed to purpose made mountings. Terminals carrying different voltages shall be segregated into groups.

Field controllers shall be suitable for operating normally within the following environmental ranges unless otherwise indicated:

1. Temperature 0°C to 50°C
2. Relative humidity 10% to 90%

Field controllers shall be protected against the effects of moisture, dust, dirt and gases.

Where controllers are free issued to terminal unit manufacturers the controls specialist shall also free issue associated interface relays and transformers as required.

Provide internal power back-up as indicated which shall hold the controller memory for a minimum period of 72 hours and maintain the controller's clock function for a period of two years unless otherwise stated. The internal power back-up unit shall be easily replaceable. The interval between battery maintenance inspections shall not be less than 12 months. Battery monitoring functions shall be as indicated.

Controllers shall have the facility to be fully configured and accessed by a portable computer and via the operator workstation. Password access shall allow the display of all configuration details associated with the field controller. Configuration details shall be easily altered by system operators.

Field controllers shall incorporate a panel mounted operator interface.

The controllers shall include run-time totalling routines to enable run-time for each item of plant selected. A different maximum run-time for each item of plant shall be allowed together with interrogation of the controller for a point-by-point summary of run-time totals and limits. An alarm signal shall be provided when the maximum run-time is reached.

Controllers shall include routines necessary to confirm that specific items of plant are functioning correctly and this can be performed by monitoring physically separate but functionally related sensors, switches or transducers. An alarm shall be raised if the expected response has not been established by a preset time following switching on of plant. The preset time shall be adjustable. It shall be possible to operate any specified standby plant.

The field controller shall be capable of logging selected hard and soft points and shall have sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points unless otherwise stated. Logging frequency and start/stop times shall be adjustable.

Controller inputs
The interfaces for field controllers shall be appropriate for gathering data from sensors and devices.

All inputs shall be scanned at intervals not exceeding 1 second and protected against spurious out-of-range signals including those caused by contact noise or bounce.

Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 0.1% of the analogue value.

Analogue input
Variable currents (4-20 mA), variable voltages (0-10V) or variable resistances.

Routines necessary to process analogue inputs shall be resident at the field controller.

Ensure that a minimum and maximum limit value can be defined for each analogue input and each limit is associated with a configured response.

The field controller shall detect open or closed circuit faults and raise an alarm on the operator workstation.

Ensure that non-linear inputs can be calibrated / scaled.

It shall be possible to define a relationship between an analogue point threshold value and a digital point status.

Digital inputs
Derived from volt-free contacts (max 24 volts/20mA). Allow the interface to be selected to monitor a normally open or normally closed circuit.

Routines necessary to process digital inputs shall be resident at the field controller.

Pulsed inputs
Derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 32Hz.

Routines necessary to process pulsed inputs shall be resident at the field controller.

The inputs used to monitor fluctuating pulse rate shall have operator adjustable limits.

The field controller shall have the following capabilities:

1. Storage of cumulative totals.
2. Operator re-set facility of cumulative totals via the workstation.
3. Facility to combine counts from separate pulsed inputs.
4. Ability to calculate the number of pulses per unit time through addition and/or subtraction.
5. Ability to compare the number of pulses with preset limits on the basis of total number of pulses per unit time and the time required for a total number of pulses.
6. Ability to convert pulsed readings into quantifiable values.
7. Alarm facility based on a user defined limit being exceeded.
8. Controller outputs
9. Controller interface characteristics unless otherwise indicated:
10. Isolation between controllers and networks shall meet the requirements of pr EN 13646.
11. Analogue output shall be as variable currents (4-20 mA) or variable voltages (0-10V). It shall be possible to characterise analogue outputs in order to obtain a near linear response from the controlled items of plant.

Ensure that digital outputs can be selected as ‘normally closed’ or ‘normally open’.

Errors introduced by the digital to analogue conversion of outputs shall not exceed 0.1% of the digital value.

In the event of power failure, output devices shall be capable of being driven to their preset, fully open/closed position.

Field controller interfaces shall be capable of providing control signals to actuators and switching devices.

Field controllers shall be capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.

Routines shall be configurable, such that one or more events maybe enabled in direct response to any defined logical relationship between the status of a number of physical or soft-points.

Outstation input and monitoring devices
As indicated these shall be provided by the use of a portable device such as a laptop or netbook PC or touch screen handheld device. All devices shall be fully capable of interfacing with the outstations via a WiFi or Bluetooth wireless connection.

As indicated a number of Palmtop CE devices shall be provided, there shall be a minimum of two units supplied. If there are less than five outstations on the system then one unit shall be provided. The local interface shall provide all the functions available at the central system

5201005 Actuators

Actuators shall be selected with adequate force/torque for the required applications.

Actuators and linkages for valves and dampers shall operate smoothly from fully open to fully closed without binding and with adequate torque to overcome the resistance of the actuator mechanism and the flow and to provide the specified close off ratings.

Linkages shall be clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.

Fit actuators with visual position indication.

Actuators shall incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.

Where indicated include position feedback devices suitable for connection to the BMS.

Actuators shall be protected both electrically and mechanically against the effects of valve or damper seizure.

Ensure that there is sufficient space so that actuators can be removed for testing and maintenance. Actuators shall incorporate electronic motor overload protection.

Actuators shall be 24V and accept typical control signal types unless otherwise indicated. Where line voltage actuators are used, local means of isolation shall be provided.

Actuators shall be protected to the IP rating for their required application.

The controls specialist shall fit actuators and required linkages to dampers and control valves.

Actuators shall be supplied complete with all necessary mounting brackets and linkages.

5201006 Valves

Valve bodies shall be suitable for the medium, the temperature and the operating and test pressure of the fluid system.

Valves shall have the correct authority without excessive pressure drop and shall pass the required flow at a pressure drop within the maximum differential pressure rating of the valve.

The control valve sizing method shall be agreed with the CA.

Ensure system operating pressures, test pressures, pump heads and pressure drops through heat exchangers and associated pipework are known before control valves are selected.

Unless otherwise indicated select valves to provide an authority of 0.3 to 0.5 for diverting applications and 0.5 for mixing applications.

Valves shall have port characteristics appropriate for the intended function.

All modulating control valves shall be selected for equal percentage or linear characteristics according to system type, to provide near linear characteristics between the valve position and heating/cooling power as delivered to the air or water-based system.

The range-ability of the selected valves shall be large enough to provide stable control under low load conditions.

Control valves shall be free issued by the controls specialist to the mechanical services installer for installation. The controls specialist shall instruct on their correct installation allowing for service and replacement.

Valves shall not be installed with their spindles in the horizontal position or with the actuator at the bottom.

Unless otherwise stated all two and three port control valves shall be plug and set types with tight shut-off and having a linear total flow characteristic. Rotary shoe and butterfly type valves shall not be used.

All modulating actuators shall be low voltage, self-stroking and have position indicators and manual override facilities. Modulating valve actuators shall incorporate positive feedback monitoring.

Where necessary valve stems shall be supplied fitted with spindle heat barriers, heaters and shields to prevent actuator over-heating or condensation causing malfunction.

5201007 Dampers

Provide visual position indicators on all damper actuators installed so that they are clearly visible.

Damper characteristics shall be as linear as possible and modulating dampers shall be sized correctly to give adequate authority.

Actuators shall have end switches for indicating the safe condition/interlock of plant/monitoring by the BMS (DDC).

Modulating dampers shall incorporate positive feedback monitoring.

5201008 Variable speed inverter drives

Inverters shall be the pulse width modulation type and shall allow the interfacing requirements as indicated.

All inverters shall be of the same manufacture and installed fully in accordance with the manufacturer's recommendations.

Inverters shall provide the following protection functions:

1. Phase loss detection (both motor and line).
2. Earth leakage.
3. Over-voltage fault.
4. Under-voltage fault.
5. Over-load/under-load fault.
6. Overheat fault.
7. Stall protection.
8. Loss of control signal.
9. Loss of auxiliary control signal.
10. Over-current protection.

Operation of any of these faults shall cause electronic shutdown without fuse blowing.

Inverters shall have the following characteristics:

1. Starting current not to exceed full load starting current
2. Near unit power factor throughout the speed range without the use of power factor correction equipment
3. Independently adjustable ramp control for increase/decrease speeds
4. Capable of connecting to a reverse windmilling fan without causing tripping and able to return to correct speed
5. Local control operation capability
6. Facility to set all operating parameters with door closed and without the use of additional instrumentation

The inverter enclosure shall be dust and damp proof and shall be protected to the IP rating suitable for the application in accordance with BS EN 60529. Adequate ventilation for cooling shall be provided.

Inverters shall have a back lit display and alpha numeric keypad.

Inverters shall be capable of electronic maintenance without the motor being connected.

Where a switch disconnector is installed between an inverter and the associated motor, an early break connect on the switch-disconnector shall be provided to disable the inverter.

5201009 Control functions and routines

Control interlocks
The BMS shall be capable of providing all control interlocks as identified.

Frost protection
Provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage.

Unless indicated provide the following two stages of protection:

When the outside temperature falls to the set minimum frost-protection temperature, the selected pumps shall start and circulation established through pipework systems and their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant shall operate on failure of the duty plant.

When the return temperature falls below the pre-set minimum, the full frost-protection facility shall be initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.

Provide a facility to allow frost protection to be logged together with data and time.

Building/plant protection
Provide protection routines to operate the plant in order to protect the building fabric and its contents against the effects of low internal temperatures and of condensation.

If the internal air temperature falls below the pre-set protection temperature, the heating system and related plant shall be turned on and heat supplied to maintain the air temperature at or above the protection set-point temperature.

The building/plant protection routine shall override other control functions unless otherwise indicated.

Protection shall operate whenever the normal heating is switched off.

Safety interlocks
All safety interlocks shall be hardwired and have precedence over all other control functions. Safety interlocks shall only be reset manually and locally (not from the operator workstation). All hardwired safety interlocks shall have corresponding software interlocks to prevent cascading nuisance alarms.

Fire interlocks
All fire interlocks shall be hard wired. In the event of a fire, all non-essential plant shall be shut down by a signal generated by the fire alarm unless otherwise stated.

Time schedules
Each field controller shall be capable of enabling plant according to multiple pre-set time programmes. It shall be possible to schedule each item of plant for a minimum of three separate switching periods per 24 hours. Separate schedules shall be capable of being defined for each day of the week.

Time schedules shall be capable of:
1. Grouped to form global time schedules
2. Defined on a weekly basis on a single ‘page/screen’
3. Defined 12 months in advance.
4. Copied from existing schedules
5. Linked to optimum start/stop control facilities.
6. Accommodating leap years.
7. Fixed extensions and contractions (the time schedule shall revert to the ‘normal’ switching periods following the extension/contraction period)

Provide:
1. Time schedule override facility to accommodate holiday periods, etc.
2. Optimum start/stop over-ride facility for user-defined override days. Optimum start/stop control shall be enabled following the override period.
3. Automatic switching between BST and GMT and back.

4. Operator over-ride facility.

Plant start/stop control
Field controllers shall be capable of starting and stopping plant according to the sequences indicated including any specific requirements for 'off' position or status of plant items, valves and dampers, etc.

Field controllers shall be capable of automatically enabling standby plant on failure of duty plant and automatically report plant failure alarms at the operator workstation. The failure of a flow switch or other device shall not continuously cycle plant.

If a flow switch fails the operator shall have the option to force either the duty or standby plant to come on.

Provide the operator with the option to override any start/stop action configured within the field controllers. When reverting to normal automatic control, ensure that the original program is automatically reinstated and updated to the correct time.

Provide delayed plant-starting facilities in order to reduce power surges. It shall be possible to start plant sequentially by adjusting the delay period for each item of plant.

Delayed plant starting shall initiate following power failure/re-instatement and plant shut down/restart on fire/fireman override.

Provide the operator with a facility to specify minimum on/off cycle times and/or the maximum number of starts per hour for specified items of plant.

Provide a plant protection routine that enables the operator to select and automatically run items of plant for short periods during out of season shut down. Run periods shall be operator adjustable.

Sequence control
Provide sequence control routines to automatically sequence the operation of multiple items of plant by monitoring load parameters and efficiently matching the plant to the load.

It shall be possible to define different automatic sequences of control. Provide the operator with a facility to override the automatic sequence and define an alternative sequence.

Set-point values for each control action shall be variable and adjustable by the operator and associated alarm limits shall be modified automatically.

The operator shall be capable of adjusting switching control differentials to prevent short cycling.

Routines shall include a facility to operate all plant ancillaries associated with sequence control, unless these have been specifically excluded.

Routines shall include the facility to proceed with the defined sequence when one of the items of plant in the sequence is isolated or fails to operate (unless the safety requirements dictate otherwise). Ensure that failed items of plant are removed from the sequence.

Plant rotation control
The relevant field controllers shall be capable of alternating the lead plant items where duty and standby equipment is installed. This shall be achieved both by an operator command and on a time-scheduled basis.

The rotation control shall be capable of being provided on the basis of run hours, elapsed time and calendar basis.

Provide routines to ensure that when the maximum number of start/stop cycles for a particular plant is reached then its schedule is automatically modified eg by rotating the standby equipment or changing the lead machine.

Ensure that each item of plant operated under rotation control can operate at any stage of the rotation sequence as indicated

The plant rotation control shall accommodate a plant failure condition, in such a way that a failed item of plant is 'replaced' by the next in the rotation cycle. An alarm condition shall be raised in response to plant failure.

Rotation control shall be capable of being initiated outside normal operating periods.

Optimum start/stop for heating systems
Provide an optimum-start routine for the heating system to compute the daily minimum pre-heat period necessary to achieve target comfort conditions at the start of occupation. Provide an optimum stop routine to compute the earliest time for the heat source to be shut down in order to retain minimum target comfort conditions in the zone at the end of occupation.

The optimum start/stop routines shall have access to the system real time clock, calendar facility and time programme to define the occupation periods.

It shall be possible to apply optimum start/stop control both to individual zones and overall plant operation.

The routines shall operate the heating and ventilation plant as necessary to achieve the required target conditions, and that the heating and cooling systems do not conflict in any controlled zone.

Provide independently adjustable start and stop comfort conditions.

Ensure that weather compensation control can be inhibited during pre-heat periods.

The heating plant shall go into full heating mode with full re-circulation of air (if relevant). Ensure a return to normal fresh air control following the optimum start period.

Provide the optimum start/stop routines with an automatic self-learning process that seeks to reduce any error in achieving the target conditions at the target time.

Provide the operator with the facility to adjust the following parameters:
1. Target temperature for optimum start.
2. Maximum pre-heat period.
3. Target temperature for optimum stop.
4. Minimum space temperature for out-of-hours periods.
5. Enable/disable the self-adaption function.
6. Default limit time for handover to the weather compensation routines after the start of occupation.

The internal and external air temperature sensors associated with the optimiser shall be positioned correctly in order to provide representative readings.

Optimum start/stop for cooling systems
Provide an optimum-start routine for the cooling system to compute the daily minimum pre-cool period necessary to achieve target comfort conditions at occupation start time. Provide an optimum stop routine to compute the earliest time for the cooling system to be shut down in order to retain minimum comfort conditions in the space at the end of occupation.

The optimum start/stop routines shall have access to the system real-time clock, calendar facility and time programme to define the occupation periods.

Routines shall be capable of operating the ventilation system for building purging prior to optimum start of cooling plant.

It shall be possible to apply optimum start/stop control both to individual zones and overall plant operation.

Provide routines to operate chillers and ventilation plant as necessary to achieve the required target conditions while ensuring that heating and cooling systems do not conflict in any controlled zones.

Provide the operator with the facility to adjust the following cooling system optimum start/stop parameters.

1. Target temperature for optimum start.
2. Maximum pre-cool period.
3. Earliest time for building purging during out of hours period.
4. Inside and outside temperature limits for building purging.
5. Separate time/temperature relationships for optimum start and optimum stop.
6. Minimum space temperature during building purging.

The internal and external air temperature sensors associated with the optimiser shall be positioned correctly in order to provide representative readings.

Weather compensation

Provide weather compensation routines to control the heating system in relation to external weather conditions. Provide the operator with the option to adjust temperature and flow-rate settings for the heating system to re-define the weather compensation.

Provide automatic adjustment to the weather compensation by comparing measured and required space temperatures with the outside conditions, and provide the facility to correct the compensation where a significant difference between the two space temperatures occurs.

Abrupt changes in the heating system performance or space temperature shall not adversely affect the automatic adaptive compensation process.

Provide a single weather compensation curve for each zone irrespective of the number of temperature sensors provided in the zone.

The routines shall respond to the reset signals arranged to achieve boost, night set-back and boiler safety.

Air temperature sensors associated with the compensator shall be positioned correctly in order to provide representative readings.

Enthalpy

This shall be achieved by comparing the return air temperature and humidity with the fresh air/external air temperature and humidity, to determine if the fresh air is beneficial to achieve the design conditions.

Load shedding

As indicated the system shall be capable of monitoring the overall rate of electrical power consumption and if a pre-set demand level is projected to be exceeded, the system shall be capable of shedding electrical load in a pre-determined manner.

The system shall be capable of as many levels of load priority as are necessary to meet the requirements as indicated. The order of priority in each level shall be capable of rotation if required.

Under conditions of partial/total power loss the system shall be able to trim demand in a controlled manner to match available power from stand-by generator sets.

If load shedding routines are set up the facility to log consumption continuously shall be provided.

Similarly, the system shall be capable of enabling loads in a controlled sequence to restore normal operation.

Cascade start

As indicated the control system shall prevent the simultaneous operation of heavy electrical loads at start up by incorporating time delays between plant start-up signals.

5201010 BMS configuration

General

Unless otherwise stated the controls system/BMS system shall have the facility to monitor and/or control the following plant/system functions:

1. External Conditions - temperature and humidity.
2. Internal Room Conditions - temperature.
3. Plant/System Status - run, tripped, fault, alarm, low level, etc.
4. Plant Time Scheduling - on/off control.
5. Optimum usage of plant.
6. Plant cycling "duty sharing".
7. Energy consumption
8. Mains failure plant operational routine.
9. Fire off interlock (for logging purposes).
10. Archive/trend logging/contingency logging.

All equipment shall be manufactured such that it shall not generate electrical interference beyond acceptable limits.

All equipment shall be suitably protected against spikes and harmonics on the incoming electrical supply and against electromagnetic radiation from site portable radios, etc. Any equipment limitations shall be stated in the tender.

Point Capability

The points schedule detailed within the tender document is indicative of the monitoring requirements and control operation of the system.

The Controls Specialist shall produce a points schedule based on the controls and BMS equipment proposed to be supplied to meet the requirements of the specification. If any points are omitted state the reasons for so doing.

A schedule of outstations shall be submitted, as part of the tender return documentation, showing the points connected to each indicating the input/output capacity supplied, and the spare capacity available for future additions.

The system shall be capable of supporting the type and number of hardware points listed as indicated and shall support all software points, programming etc necessary for the specified control sequences.

Each control panel shall be provided with a minimum quantity of 15% surplus of hardware points of each point type at the time of tender.

The Controls Specialist shall clearly state in the tender return the used and spare point capacity for each controller.

Password protection

The BMS software shall be protected from unauthorised entry.

Unless otherwise indicated provide, as a minimum, password-protected operator access for the following levels:

1. Level 1 Ability to display all point data
2. Level 2 As level 1 with ability to initiate data logging functions
3. Level 3 As level 2 with ability to change user-adjustable set points and time schedules
4. Level 4 As level 3 with ability to change control strategies, schematic/graphics functions and password assignment.

Password-protected operator access shall be set up for both operator workstations and field controllers which have an operator interface. A common overall system password set and procedure shall be provided whether access is gained from operator terminals, portable terminals or keypads on single or multi-site schemes.

Passwords shall permit at least 6 alpha/numeric characteristics and users shall be able to change their password/pin numbers at will.

At operator terminals a user logging-on shall be recorded with time and date. Unless otherwise indicated logging off shall be command or time-out from non-use of the keyboard or mouse with the event again recorded.

5201011 System communications

General

The system communications shall allow the full transfer of monitored, logged, alarm, backup and configuration data between the operator workstation and addressable field controllers.

The communication protocol selected shall seek to achieve error-free data transfer and shall include an error detection check, error correction and/or re-try technique. The protocol shall limit re-transmission and raise an alarm condition on failure.

The available bandwidth shall be sufficient to avoid excessive delays in transmitting data. The maximum permissible time delay shall not exceed that indicated.

Modems shall comply with BS 6320 and the speed of modems shall be as indicated. Connections to telecommunication systems shall comply with BS 6701.

Provide an ISDN link if defined unless otherwise indicated.

Field-level protocols shall:

1. Run on the required communications media
2. Provide a communications throughput sufficient for the intended application
3. Provide appropriate network topology options
4. Allow sufficient maximum physical segment length
5. Allow sufficient maximum number of nodes for each physical segment and the logical network
6. Provide sufficient maximum distance between nodes
7. Make use of off-the-shelf network devices such as repeaters, bridges and routers
8. Allow control devices to be powered from the network where indicated.

Ensure that the field-level protocols are compatible with fully developed network configuration and management tools.

Direct interoperability

Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.

Ensure that each of the protocol's arrangements for physical connection, data packaging, network management and error detection/correction are the same.

Gateways

Gateways shall:

1. Transfer the specified maximum number of points
2. Limit loss of functionality to the level specified
3. Add functionality where specified
4. Limit any time delay across the gateway to the maximum indicated

Ensure that the specified contingency and alarm measures in response to a failure of the gateway are met.

The gateway shall be capable of any modification in response to any future changes relating to the type and amount of data transferred over it.

The controls specialist shall be responsible for the implementation of any gateways.

If gateways or any other network devices are not indicated but are required to make the network function correctly they shall be provided.

Communication networks

All addressable control devices shall be addressed over the communication network.

The bandwidth and subsequent speed of communications shall be sufficient to meet the requirements as indicated.

No cross corruption of data shall occur when the system shares a communication network with other IT based systems.

Network testing, identification and documentation shall comply with BS EN 50174.

All network devices shall be compatible with the network and are capable of operating such that the required throughput of data is achieved.

BMS devices to be directly connected onto the Intranet/Internet shall be TCP/IP compatible.

Where radio communications are employed the radio transmitter/receiver and the BMS components shall be adequately powered. The lifespan of batteries shall be as indicated. Radio communications devices and associated BMS components shall be easily accessible to allow the change of batteries. The attenuation of radio signals shall not hinder effective data communications.

Mains-born signaling shall comply with the requirements of BS EN 50065-1:2001+A1:2010

Provide the necessary equipment to ensure that there is no mutual interference between the signaling system of the electricity utility and mains-borne signaling of the BMS.

5201012 Integration with fire detection systems

The controls specialist shall liase with the fire alarm specialist and all other relevant parties in the integration of the systems.

The controls specialist shall be responsible in conjunction with others in obtaining all necessary approvals from the Fire Officer/Building Control Officer.

The fire detection system shall operate autonomously and will not be affected by any failure of the BMS. The BMS will not be affected by any failure of the fire detection system or fails safe as appropriate.

The loss of electrical power to the BMS will have no adverse effects on the fire detection system.

A full cause and effect testing programme shall be developed in conjunction with the fire alarm specialist and agreed with the CA.

The integrated system shall be fully commissioned.

Provide the display of fire alarm detector status information on the BMS operator workstation as detailed elsewhere

Provide any specified building graphics/schematics on the BMS operator workstation indicating the location of fire detector heads or zones, as indicated, along with their respective status.

The fire alarm condition shall automatically display the appropriate building graphic/schematic along with relevant detector head status or zone status as indicated.

Any time delay in receiving the fire alarm data at the operator workstation shall not exceed the maximum as stated.

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Provide fail-safe, hardwired interlocks using volt-free contacts between the BMS field controllers and items of plant as stated elsewhere.

As indicated use relay logic and/or microprocessor-based logic.

Any specified building services control actions shall operate correctly in response to the status of the fire detection system.

5201013 Operator workstation

Operational characteristics
The control of plant shall be independent of the operator workstation. Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.

No data of a control nature shall be transferred between field controllers via the operator workstation unless otherwise indicated.

The operator workstation shall communicate with all addressable field controllers. The appropriate control strategy configuration data shall be capable of being downloaded to all addressable field controllers.

Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the operator workstation.

All control strategies and associated control parameters shall be altered via the operator workstation.

The operator shall be capable of re-scheduling plant operation times. Re-scheduling shall be capable of being applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.

The operator workstation shall incorporate a data storage management system that warns against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-line non-volatile media. The operator shall be prompted at pre-defined intervals to carry out the data archiving procedure.

It shall be possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.

Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data).

Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.

The backup data shall be capable of being fully re-loaded and that selected files from the backup data can be re-loaded.

Processor
The processor speed of each operator workstation shall be adequate to meet the data processing requirements. Delays in processing system data shall not exceed that indicated. All necessary power supply and interconnecting leads shall be provided.

Monitor
Unless otherwise indicated provide a minimum of 1N^{o} 19" widescreen LCD flat screen colour monitor with a minimum resolution of 1280 x 1024 pixels complete with adjustments for display positioning, screen brilliance and contrast.

Keyboard
Provide QWERTY keyboards with full upper/lower case ASCII key-set, numeric keys and mouse. The keyboard shall also include dedicated, or user defined 'soft' keys, which initiate the most frequently used functions.

Systems incorporating a touch-screen facility in place of a keyboard shall be provided with a keyboard connection and associated functionality.

Printer
Provide an A4 colour printer as indicated. The printer shall be capable of printing:

1. All monitored and logged data (including graphs of logged data)
2. All point data (hard and soft)
3. Graphics, control logic diagrams and plant/building schematics in colour
4. Alarm data/text and to list any appropriate action to be taken.
5. Systems help text.
6. Reports in letter quality format.

The automatic printing of alarm data shall be capable of being switched on/off.

The controls specialist shall provide sufficient paper and ink until practical completion, at which point the printers shall be reloaded with a fresh supply and the end user issued with two boxes (5000 sheets) of spare paper as well as two full sets of branded ink cartridges.

Monitoring and logging functions
All monitored point data shall be displayed at the operator workstation. Analogue, digital and soft-points shall be displayed simultaneously.

All changes made by the operator (eg set-point changes) shall be logged and identified by both operator and date/time stamp.

Provide a facility to allow the display, at the operator workstation, of 'real time' data superimposed on plant schematics with a refresh rate not exceeding 20 seconds unless otherwise indicated.

Ensure that a minimum of four 'real time' data points can be displayed simultaneously, in the form of data plots, with a time delay not exceeding 20 seconds.

Provide a facility to allow the monitoring and display, on the same 'page', of common criteria/plant functions.

Any hard or soft-point log shall be capable of being displayed and stored on the operator workstation.

Logs shall be capable of being set up from the operator workstation and logging times and logging intervals shall be adjustable between 1 second and 24 hours.

The operator workstation shall have sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.

Provide a facility to allow the simultaneous display of different logged data. This function shall be operator adjustable.

Provide a facility to allow the export of logged data to other software packages as indicated.

Graphics
The controls specialist shall include for system graphics print-outs for review by the CA and off-site demonstration of the graphics before final incorporation into the BMS.

The BMS shall incorporate the facility for a colour graphics package to be installed at the operator's terminal/desktop computer. The system shall be an active graphics presentation and include the following features unless otherwise indicated:

1. Provide a software library of plant schematics and symbols, the format/contents shall be agreed with the CA.
2. The operator shall be able to select a plant location and associated control panel from a plan and via a hierarchical set of graphic layouts select a particular plant, point or point attribute.
3. A detailed schematic of each plant area or individual plant monitored or controlled by the system shall be available for viewing and interrogation at the operator's terminal. The schematics shall illustrate the status and analogue values of all points associated with the selected plant. The value of such points shall be updated while the schematic is displayed to the user.
4. Provide a facility to allow the operator to generate additional schematics and symbols.

5. The system shall accommodate the addition of 20% extra graphics 'pages'.
6. Provide a facility to allow the operator to modify plant schematics and to generate new ones.
7. The graphics shall be capable of being displayed in a layered approach (building layout graphics down to plant subsystems and components). The operator shall be able to modify the structure of the layered approach.
8. Graphic selection and use shall be primarily mouse driven. However, the user shall also be able to access data direct by reference to a point or report name.
9. Multi-level password protection shall be provided for all interfaces.
10. Print outs of all system graphics shall display the date, time and external ambient temperature and humidity conditions.
11. The operator shall be able to select and modify any point attribute as required.
12. The operator shall be able to change alarm limits or set points associated with a point or allow access to the DDC programme code.

Help and assistance
Provide a facility to allow the display of help text covering all operator functions and system fault conditions.

Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy logic schematics.

Energy monitoring and targeting software
As indicated, provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BMS to monitoring and targeting software in an agreed format.

Maintenance management software
As indicated, provide a facility to allow the direct transfer between the BMS and maintenance management software. The format and scope of the exported data shall be as indicated.

System alarms
System alarms shall meet the following requirements unless otherwise indicated:
1. Alarms shall be displayed on a rolling basis in chronological order.
2. The operator shall be able to acknowledge alarms, including muting of audible or flashing annunciators. A facility shall be provided to silence audible alarms or inhibit flashing annunciators without performing alarm acknowledgement.
3. The operator shall be able to alter the limits at which the measured values cause alarms to be triggered. Alarm limits shall accommodate sliding limits eg setpoint changes.
4. Alarms shall be differentiated by means of alarm type and identification.
5. Alarms shall be prioritised (including a high priority that will be annunciated regardless of other activity) and a low priority or information status that is only annunciated on demand.
6. The time taken to receive alarms shall be as indicated.
7. The reception and acknowledgement of alarms shall take precedence over other operations and shall not hinder user log-in.
8. Allow the user to acknowledge alarms individually and on a group basis.
9. Provide distinction between active alarms whose condition are not cleared and unacknowledged alarms.
10. Alarm data shall provide:
11. Condition identity
12. Condition value
13. Alarm source
14. Alarm time and date
15. Acknowledgement status.
16. Allow alarms to be automatically redirected to other user interfaces.
17. Provide sufficient data storage capability for the storage of alarms. Any stored alarm data shall be analysed in conjunction with other monitored conditions or stored logged data. An alarm review facility shall be provided.
18. The operator shall be able to define:
19. The requirement for acknowledgement of alarms
20. A time programme for annunciation of alarms to different destinations
21. Text messages associated with alarm conditions.

5201014 Energy metering

As indicated the controls system/BMS shall monitor and record energy consumption data from all meters as identified elsewhere via pulsed inputs.

The protocol selected for the communications interfaces shall be co-ordinated with the meter supplier/manufacturers and fully developed, proven and tested off-site prior to installation.

As indicated the BMS shall include the facility to generate, either automatically or via operator command, daily, weekly, monthly, quarterly or annual reports of energy consumption for operator selectable times of day, on an individual meter, tenant, floor zone or energy type basis which can be printed, archived or exported to third party proprietary applications as required.

Reports shall be produced in an agreed Microsoft office format.

5201015 Connection to plant and control equipment

Provide all devices and terminals necessary to connect the BMS to items of plant and control equipment.

Take account of any existing services that have to remain in continuous operation. Agree with the CA the method by which controls system/BMS equipment can be installed without disrupting the operation of the building services.

Where plant and control equipment are supplied by others, provide the Project Supervisor with adequate details of installation requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BMS connection facilities before delivering their equipment to site.

Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed connections or modifications do not invalidate the warranties.

Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the controls system/BMS works. Carry out proving tests to the satisfaction of the CA.

Ensure that the use of existing relays, contactors, starters and switches as part of the BMS installation is fully documented.

Provide interlocks as indicated to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power.

All safety hardwired interlocks shall be wired to failsafe on loss of power, or on relay coil failure, or on open circuit.

Unless otherwise indicated all interlocks shall use voltage-free contacts and 24v AC or DC relays and field wiring.

Complete all wiring and testing of all hard wired safety interlocks to ensure safe and/or sequenced operation of the plant before the controls system/BMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BMS.

Ensure that plant does not operate using the BMS until all interlocks have been tested to the satisfaction of the CA.

Provide manual control facilities as indicated to enable plant maintenance/facilities staff to operate essential plant in the event of BMS failure and for routine test purposes. Unless otherwise stated facilities shall include:

1. Start/stop operation of the plant

2. Automatic operation of motorised control devices such as valves and dampers, etc if the BMS is operating
3. Manual setting of motorised control devices such as valves and dampers, etc if the BMS has failed.

The manual control facilities shall not override safety devices or hard-wired interlocks.

The contact materials for volt-free contacts shall be suitable for use in the installation and at the required voltages and currents. Unless otherwise indicated screw down or locking spade terminals shall be used for electrical connections to volt-free contacts.

Provide additional contacts for signalling and remote operation purposes from starters as stated elsewhere.

The controls specialist shall liaise with and obtain all necessary information from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.

Connections to packaged plant shall be made within the packaged plant control panel. Fit an additional enclosure where this is not possible

5201016 Cabling

All wiring shall be installed in accordance with BS 7671 and the requirements as stated elsewhere.

The controls specialist shall be responsible for power, control and network communications wiring. This includes the provision of primary and secondary containment as necessary and indicated.

Low voltage power, extra low voltage control and network cabling shall be segregated throughout the installation. Under no circumstances shall power and control / network wiring be run in the same containment, regardless of the cable types. Control cabling shall be routed clear of all lighting ballasts and other electromagnetic devices that may damage the integrity of the control signal. Control system/BMS cabling shall not be mixed with cabling associated with other services.

The types of cable installed shall not prejudice the operation of the controls system/BMS.

Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit resistance limits are not exceeded.

The method of installation and routing of cables shall not compromise the satisfactory operation of the controls system/BMS.

All cabling shall be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.

Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc from external sources to sensing devices.

Communications cables as used on a network system shall be shielded twisted pair, with the shield earthed. The conductor cross sectional area, cable capacitance and length of runs shall not impair performance or violate the manufacturer's recommended network constraints.

Where Ethernet or similar carrier technology is utilised, cables specific to that technology shall be employed.

All extra low voltage controls system/BMS cables shall be run in screened twisted pair cables with the shield earthed at one end only.

Cables shall be affixed to tray, drawn into conduit or trunking and protected as agreed with the CA to suit the various environmental, local and mechanical locations. Cable containment details shall be as indicated elsewhere.

Cable specifications shall meet the manufacturer's requirements, particularly respecting overall resistance and capacitance limits.

No joints shall be allowed in cables, where these prove necessary the cables shall be joined using an approved housing, securely fixed and having cable securing clamps. Any such connecting boxes shall be shown on the record drawings.

All field cables shall be the LSF type.

Power and control cables associated with the operation of life safety plant shall have fire rating classifications CWZ to BS 6387 and shall be approved by the CA and Building Control prior to installation.

Field switch disconnectors and junction boxes associated with life safety plant shall be fire rated.

All cables shall have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification as indicated. The identification shall be consistent with the relevant wiring diagrams.

Electrical installations shall be undertaken by companies approved by the National Inspection Council for Electrical Installation Contracting. Test and completion certificates shall be issued following completion of each section of the installation and for the completed installation.

Use of existing cabling and wire ways

Confirm by testing that any existing means of network communication is of a suitable standard for satisfactory operation of the BMS. Any tests shall be performed in compliance with BS EN 50174. Ensure that the potential corruption of data cannot arise.

At the time of tender state in writing whether or not existing cabling is suitable

5201017 Commissioning and testing

General

Include for carrying out the tests as stated, together with such additional inspections and tests during the process of manufacturing, installation or otherwise as the CA shall prescribe, to prove the physical characteristics of all materials and manufactured parts incorporated in the Works, ensure the overall suitability of all equipment, and to satisfy the requirements of the Local Authority.

The testing and commissioning shall be co-ordinated with all other trades and shall be performed in a systematic and methodical manner in accordance with the contract programme.

The controls specialist shall ensure satisfactory completion of the testing and commissioning together with the recording of results.

Appoint a "competent person" to supervise the whole of the testing, commissioning, system proving, system demonstration and instruction of the employer's staff.

Include for all expenses, labour, materials, tools, equipment, plant, calibrated instruments and attendances required for inspections, testing, commissioning and demonstrations of the control systems.

System commissioning shall be in accordance with CIBSE Commissioning Code C - Automatic Controls and as indicated elsewhere.

Undertake the following:

1. Off-site testing and demonstrations
2. Testing, pre-commissioning checks, commissioning, regulation and setting to work of the controls systems

3. Preparation of comprehensive programmes, commissioning plans, schedules and method statements and procedures supported by risk assessments for the pre-commissioning checks, setting to work, commissioning, system proving and environmental testing
4. Provide and submit standard pro-forma for the various requirements for commissioning records and certification for agreement with the CA prior to commencement on site
5. Monitor progress against the program of works and provide weekly reports detailing progress of testing and commissioning activities
6. Maintain a diary/log of all significant activities and document any faults, snags or queries and how these were resolved. The diary/log shall be fully noted and available for inspection by the CA at any time.
7. Ensure all certification is attained and witnessed as necessary for inclusion in the record documentation
8. Provide and submit a report for every test, demonstration, or commissioning activity witnessed, together with an engineering appraisal on the performance, either on or off-site
9. As necessary co-ordinate and liaise with the Employer's representative
10. Co-ordinate, give notice and obtain all approvals from the necessary authorities
11. Provide operator training and demonstrations to the Employer's staff or representative

Programme
Within one month of appointment, unless stated otherwise, submit to the CA a preliminary commissioning programme. The programme shall be of the itemised bar chart format and shall clearly indicate the proposed approach and all key activities including off site testing, witnessing etc.

Prior to commencement on site, unless stated otherwise, the installer, controls specialist and commissioning specialist shall together produce a detailed and final commissioning programme. This document shall amplify and expand upon the preliminary commissioning programme and include all necessary detailed method statements and procedures. The programme shall be fully integrated with all other site activities envisaged to be occurring during the period of commissioning and shall also indicate all necessary witnessing and acceptance dates.

Reports
Submit to the CA written reports signed by a qualified person to confirm that:

- Prior installation - all system designs can be commissioned
- Post installation - installations complete and ready for testing and commissioning
- Pre-commissioning checks – completion of pre-commissioning checks and all off-site testing
- Commissioning and testing – to demonstrate compliance with specified requirements and confirm that the controls system has been correctly tested and commissioned and achieving the specified performance.

The final documentation of reports and completed record sheets shall be compiled into a control systems commissioning manual for inclusion in the operating and maintenance documentation.

Instruments for testing and commissioning
All instruments shall be provided by the controls specialist.

Submit to the CA a schedule detailing the equipment and instruments to be used in the testing and commissioning of the controls systems.

Ensure all instruments are correctly calibrated and are marked with a unique reference for identification. Submit evidence of correct calibration of all instruments used in connection with commissioning and testing to the CA prior to commencement of the Works. Test methods shall be demonstrated to the CA where required.

Instrument calibration data and identification shall be included on the respective test record sheets.

Off-site testing
The controls specialist shall include for off-site testing of all control panels, control application software and user interface software unless otherwise indicated.

The controls specialist shall include for all travel and accommodation expenses of the CA unless otherwise indicated.

The requirements for off-site testing shall be as stated elsewhere.

Testing shall be to the satisfaction of the CA and certificates of all such tests shall be provided to the CA within 3 days of testing and copies included in the operating and maintenance documentation. All certificates shall be signed by a competent person and witnessed.

Off-site testing will be required to be repeated on site as directed by the CA.

Ensure that as much pre-commissioning work as possible is perfomed off-site as agreed with the CA.

System demonstration

The controls specialist shall:

1. Give 10 working days' notice to the CA of his intention to undertake the acceptance demonstrations and witnessing.
2. Ensure that sufficient on-site resources are available to facilitate the demonstration and witnessing process.
3. Submit to the CA a detailed programme of the demonstration and witnessing activities prior to commencement.
4. Issue a complete commissioning report to the CA prior to commencement of the demonstration and witnessing period. The report shall contain the commissioning point-to-point checklists and details of commissioning values and parameters installed, signed and dated accordingly. The report shall be revised as necessary on successful completion of the demonstration.

At the discretion of the CA, and unless otherwise stated, the following shall be demonstrated and verified in the presence of the CA:

1. Any operator software and associated graphics
2. All safety related functions
3. All plant restarts according to that specified after building failure and local power failure
4. All power meter data-points to ensure that they match the meters
5. All optimiser and time clock energising of plant. Demonstration of any optimiser shall include the switching of all required plant during 'non occupation period' under simulated frost and internal condensation conditions.
6. All safety interlocks, overrides and fail-safe conditions. To be operational prior to starting the plant and demonstrated as agreed with the CA prior to starting plant in BMS auto-mode.
7. Fault conditions for all critical alarms, safety devices and control interlocks shall be simulated and proved effective as soon as practical once BMS control mode is selected.
8. All controls associated with terminal units. Random checks at the discretion of the CA to demonstrate correct operation of the units including temperature, volume and pressure checks as necessary.
9. Sensors to ascertain accuracy within limits. Humidity sensors shall be checked for accuracy using a wet/dry bulb thermometer.
10. Fire condition including operation of plant available to the Fire Officer in an emergency situation.
11. 10%of all points shall be selected by the CA and demonstrated for operation and accuracy. The CA reserves the right to witness 100% of the points if the failure rate is greater than 5%. The Controls Specialist shall ensure sufficient man-power, test equipment, consumable items and portable communications equipment to conduct the demonstration efficiently.
12. The system security access.
13. One of several identical items of plant in detail with the others witnessed on a random basis.
14. The control of critical items of plant.
15. Dynamic graphics.

Trend graphs will be provided to demonstrate the stable control of the plant. Simulated inputs will be employed to check stability over the design environmental range.

Electrical services

Inspection and testing shall be carried out during installation and after completion of the works.

Tests shall be carried out on site after completion to ascertain the insulation resistance of the conductors, cables and accessories and fittings to earth and between poles, the electrical continuity of metal sheaths surrounding conductors, and the polarities of all accessories and fittings, complying with the latest edition of the IEE Wiring Regulations 17th Edition with amendments ruling at the date of tender.

Unless otherwise indicated all tests shall be undertaken in the presence of the CA who shall have been duly notified. Triplicate copies of test certificates covering all tests carried out on the completed installation shall be submitted to the CA.

5201018 Training

The controls specialist shall provide user training course(s) for the Employer's personnel in the operation, maintenance and programming of the controls system.

The first course will take place after commissioning and prior to handover.

The second course shall take place within 6 months of the handover date tailored to suit the end-user requirements.

Training will be provided by competent instructors. All associated training equipment required by the instructors to enable the training to be demonstrated effectively shall be provided.

Submit to the CA for approval a detailed training programme and method statement for the training of the Employer's staff.

Where necessary provide off-site training at the controls specialist training facility.

A training manual, together with a comprehensive set of teaching notes and diagrams, shall be provided for each operative

For all instruction periods maintain training records which shall be submitted to the CA on completion. All attendee names shall be recorded and signatures obtained from all attendees confirming they have understood the training given. A schedule of names shall be provided within the operating and maintenance documentation.

As indicated the training shall include but not be limited to:

1. Operation of user terminals
2. use of displays and add or change graphics/ schematics
3. call up and view point-data from plant schematics and/or points lists
4. overrides
5. acknowledge system alarms and setting up alarm routines
6. Undertaking basic alterations
7. Time and occupancy programmes
8. Control set-points
9. Setting up trend logs
10. Testing and routine inspection of sensors and actuators
11. Adding analogue and digital inputs/outputs to the system
12. Re-load system software/configuration details
13. Add/modify passwords/monitor system security
14. Instruction on the procedures for fault-finding, tuning, maintenance, testing and routine inspection and to assess the nature of faults and extent of remedial action required.
15. Instruction on the configuration of outstation
16. Specific system structure including outstations and control strategy overviews.
17. Back-up of the system and archive logged data.

The controls specialist shall be available for 8-weeks following practical completion to assist the Employer's personnel in the operation of the various systems during occupation of the building.

The Controls Specialist shall provide off-site communications support through a modem connection during the defects liability period of 12 months.

All costs associated with the instruction of the Employer's staff and required attendance following practical completion shall be included in the contract price.

5201019 Post – Handover Checks

During the 12 months after practical completion and in consultation with the CA undertake to:

1. Assess the need for fine tuning of the installations
2. Ensure the requirements for fine tuning are incorporated in the commissioning specification
3. Ensure that fine tuning activities are programmed, planned in advance and agreed with the CA and employer prior to commencement
4. Ensure that fine tuning activities are planned with regard to the health and safety of occupants and such that any disturbance to them is minimised
5. Provide a mechanism by which the Employer can provide feedback on the performance of the building both before and after fine tuning
6. Attend meetings as requested by the CA to deal with issues arising from fine-tuning of the controls system.

The costs for fine-tuning and adjustment of the controls systems during the 12 months after practical completion shall be included in the contract price.

As agreed with the CA the Controls Specialist shall include the following as part of the post-handover checks unless otherwise indicated:

Global level checks of:

1. Internal air temperature
2. Relative humidity
3. Ventilation
4. Energy consumption (ensure that the pulse-input counters match the meters)
5. Control set-points meet the specified requirements.
6. Control loop settings result in accurate and stable control. Check that all self-learnt characteristics are valid.
7. All relevant field controllers communicate properly. Check for correct sharing between controllers of relevant data and correct inter-controller operation.
8. Occupant controls work correctly.
9. Sensors. Check the accuracy and location of any suspect sensors
10. Actuators. Check that any suspect actuators operate correctly.
11. Dampers and valves. Check that any suspect dampers and valves are not jammed and that they operate as intended.

5201020 Documentation

The Controls Specialist shall provide the following documentation as part of the overall record documentation for the project
System documentation will be provided at contract completion and in a format compatible with the overall project record documentation.

Operation and maintenance manuals

A preliminary copy shall be made available to the CA in sufficient time for comments to be incorporated.

The operation and maintenance manuals shall include but not limited to:

1. A written description of plant operation
2. Control strategy/logic diagrams recording the final version of configuration software installed
3. Details of system application software configuration
4. A points list including hard and soft points. All points shall have a unique reference
5. A description of user adjustable points
6. Commissioning records and final commissioning report
7. Detailed data sheets for all control components and equipment
8. Wiring circuit details including origin, size, route and destination of each cable
9. Diagrams showing the full diagrammatic (network structures, configuration diagrams, flow charts, outstations, peripherals etc) and physical layout of the controls system and components.

10. Security management and access details
11. Comprehensive instructions for switching on, daily operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions
12. Instructions for any precautionary measures necessary
13. Instructions for the routine operation of the control system including simple day-to-day guidance for those operating the control system with limited technical skills
14. Instructions for servicing and system upkeep
15. A provision for update and modification
16. Suppliers and spare parts references, contacts, telephone numbers, and addresses shall be supplied where relevant.

5201021 Software

Two complete sets, unless otherwise indicated, of all software developed by the Controls Specialist shall be provided for retention by the Employer.

Allowance shall be made to up-date the software as maybe necessary during the one year defects period.

Obtain on behalf of the end user all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating.

Back-up copies of all system configuration files and master software disks shall be supplied in an appropriate lockable storage facility. All system and data files shall be current as at the hand-over date, disks to be suitably identified and directories and files cross-referenced in the maintenance manuals. In addition to the operating software, each disc will also contain a complete set of original set points for all conditions. The storage unit and key shall be handed to the Employer at handover.

A further copy of all master software, system configuration files etc shall be maintained off-site by the Controls Specialist for a minimum period of three years or as otherwise indicated.

All passwords shall be provided at handover.

5202000 BMS/AUTOMATIC CONTROLS – PARTICULAR REQUIREMENTS

5202001 General requirements

The Installer shall employ the Trust's BMS/controls specialist to design, supply, install and commission a complete and fully operational automatic controls system which shall interface with the existing systems in use on site.

The Controls Specialist shall be responsible for:

1. The design and engineering of the complete automatic controls system including all necessary co-ordination
2. Providing all materials to form a complete and operational system as indicated
3. Off-loading, positioning and fixing of all control panels
4. Installation
5. Supervision of the installation
6. System calibration
7. Software programming
8. Testing and commissioning
9. Completed system demonstration to the CA and Employer
10. Employer training
11. Record documentation

It is acknowledged that different systems offered by BMS specialists may vary in matters of system architecture, software, integration and other details. It is the intention of this specification to outline the functional requirements of the system, and it is expected that the final BMS providers shall base their proposals on their proprietary systems. However, where any deviation from the specification is proposed, this must be analysed to ensure that the system offered is fully compliant with the requirements of the final BMS specification.

The control system shall be based on a Direct Digital Control (DDC) or electronic type as indicated.

The Controls Specialist shall ensure that the selected control strategies are appropriate for the building services systems and their intended application.

The following information shall be submitted to the CA for review and comment prior to manufacturer and installation:

1. Description of controls operation
2. Network schematic (detailing all computer hardware, interfaces, locations and cable specifications)
3. Control panel layouts, wiring diagrams and labelling
4. Wiring schematics and general arrangements
5. Equipment schedules (listing control sensors, valves, computer hardware and software and any other devices)
6. Electrical installation details (identifying for power, control and network cables the proposed method of containment and cable types)
7. Power cable sizing calculations
8. Method statements for:
9. Testing and commissioning
10. Proving of the system and demonstration
11. Off-site works inspection and testing
12. Installation of site wiring
13. Technical details of all field and panel mounted equipment
14. Control valve schedule
15. Schedule of proposed set points
16. Final points schedule
17. Specification of front-end terminal equipment
18. Front-end colour graphics pages
19. Schedule of alarms and priorities

The controls system supplied shall consist of proven components that are built and manufactured to established industry standards which support the communications scheme indicated and do not require customisation or modification to meet the requirements of the specification.

The BMS/controls system specialist shall be responsible for obtaining from others all necessary electrical information with respect to electrical ratings and loads for plant and equipment. Prior to manufacturer the BMS/ controls system specialist shall confirm all associated plant electrical ratings.

The control functions and duties shall be as set out in the appropriate schedules, specification and system design as described elsewhere.

Where ancillary relays and timers, contactors, etc., are required to fulfil the control function, these shall be provided even if not specifically defined in detail.

Prior to orders being placed the Installer and Controls Specialist shall ensure adequate engineering time is allowed to meet the programme.

The Controls Specialist shall be responsible for the final positions of all thermostats, detectors, valves, etc. to ensure their correct function.

The response time of all control sensing and activating equipment shall be related to the needs of the installation under control, so as to ensure quickness of response consistent with freedom from hunting and instability.

The control system shall be sufficiently sensitive to meet the control band requirements specified without hunting.

All external control items shall be suitable for mounting externally and be suitably weatherproof.

Any limitations in respect of the degree of stability of the control system shall be drawn to the attention of the CA at the time of tendering.

The Controls Specialist shall include for the installation of all items of control equipment such as valves and thermostats in wells or in ducts and for the mounting of valve and damper motors/actuators.

Samples shall be provided to the CA for review and approval prior to ordering as indicated.

The BMS system, components, and installation shall incorporate at least 25% expansion without redundancy. Provide each outstation with additional spare capacity of:

1. Digital inputs 25%
2. Digital outputs 25%
3. Analogue inputs 25%
4. Analogue outputs 25%

Any witnessing or independent checking by the CA shall be carried out solely at the discretion of the CA as considered necessary.

All equipment and components associated with the controls system/BMS shall be handled, stored and installed in accordance with the manufacturer's recommendations.

All equipment shall be installed to ensure safe access for operation and maintenance. Access shall be fully demonstrated to the CA when requested.

Control components shall be adequately supported to ensure no strain is imposed on components.

5202002 Performance objectives

The objective of the Building Management System (BMS) is to control and monitor the building engineering systems and services throughout the development, and to provide feedback of plant and system performance. The BMS shall analyse this data to enable optimum use of the

engineering facilities within the development with minimum of human intervention and with the optimum use of energy consumption.

The Building Management System shall be based upon an 'open protocol' system, based upon standard off-the-shelf hardware and proven software.

The Building Management system shall be independent of all other systems but shall interface with the following systems to display the monitoring and alarm data at any designated supervisor station:

1. fire alarm
2. Generator control / management system
3. LV load control / monitoring system

5202003 Plant operating criteria

Plant items shall be suitable for operation in the environment that they are to be located.

All plant, motors, starters, electrical wiring, controls and ancillary equipment shall be suitable for operation at full capacity under the agreed conditions:

Ensure that the correct classes of insulation of motor windings are used and thermal overloads, relays, trips and other such heat sensitive devices are rated accordingly.

In addition the selection of materials and equipment shall be suitable for the application with regard to the possible effects of ingress of dust or sand and damp humid conditions.

5202005 Exclusions

Exclusions from the BMS scope of works for this project are:

1. Not Applicable.

5202006 Free issue equipment

The BMS/controls specialist shall hand free issue plant and equipment for incorporation into the works as follows:

- Motorised valves – Fuel Delivery System ("free-issue" to mechanical installer)
- Sensor pockets – pipework ("free-issue" to mechanical installer)

(Note: The term "sensors" includes all field equipment, which form part of the BMS/controls system)

The BMS/Controls specialist shall provide power and control wiring and final connection to all items stated.

5202007 Interfacing requirements

BMS/controls specialist shall allow for all necessary co-ordination with other trade contractors, manufacturers and specialists to ensure the correct provisions are allowed.

5202008 Network architecture

The BMS network architecture shall be a resilient multiple-ring dual-redundant network, without a common point of failure.

5202009 General control philosophy

As per existing system in use on site

5202010 System requirements

Operator Facilities

The following automatic and manual facilities shall be provided:
1. automatic operation
2. manual operators actions
3. data handling
4. alarm handling
5. alarm status
6. reporting function
7. dynamic colour graphics

Equipment

The following equipment, components and facilities shall be provided:
1. central processor unit for the head end
2. visual display unit (colour monitor) for the head end
3. keyboard
4. data storage
5. printers

Outstations

The following facilities shall be incorporated /provided:
1. stand-alone operation
2. interruption of electrical power supply (preserve software & data)
3. self-testing
4. data gathering and storage
5. control signals to field devices
6. user interface on site
7. sealed enclosures to IP 41 minimum internally when within a MCC or IP54 and IP65 externally
8. circuit board/components and field device terminations
9. outstation programming

Integrators

Integrators shall be provided to the network/outstation(s) for interface of other systems.

Monitoring Routines

The following facilities and software routines shall be incorporated/provided:
- to process all inputs resident at the outstation(s)
- initiated by any binary inputs
- initiated by any analogue inputs
- initiated by any pulsed inputs
- positive feedback
- run time totalisation
- trend logs

Control Routines

The following command and control routines shall be provided:
1. general good housekeeping control routines
2. control modes i.e. P, P+I, P+I+D or as independently selected
3. time control
4. start/stop control
5. plant protection during shut down
6. sequence control
7. chiller management
8. variable speed (inverter) drives
9. optimum start/stop control of heating system
10. optimum start/stop control of cooling systems
11. weather compensation control

12. frost protection
13. building/plant protection
14. load cycling control
15. fresh air control
16. air quality control
17. occupancy control
18. fire control

Communications

The following facilities and hardware/software routines shall be provided:
two way data communication between the various outstations or operator facilities
software for alarm messages data reporting/handling & updating and self-diagnostics
data distribution equipment/modem for auto answer, auto dial out and auto redial out.

Sensors and detectors
The following features/facilities and equipment shall be incorporated/provided:

1. sensors, detectors, meters, devices, etc to be suitable for temperature, humidity and medium being sensed/controlled
2. temperature sensors
3. temperature thermostats
4. humidity sensors
5. air flow sensors
6. water flow sensors
7. air pressure sensors and switches
8. water pressure sensors and switches
9. motorised valves – actuators and bodies
10. motorised damper actuators only
11. level detectors where applicable

5202011 Controls functions

The BMS/controls system shall provide a complete and fully automated DDC intelligent energy conscious command, control, monitoring and reporting system. The scope of the control functions are outlined as follows:

Command and control
Operating times of all HVAC plant, with sequenced start-up as dictated by operational requirements.

Plant/systems to provide and maintain internal design:
Monitor/status/alarms
1. Flow failure for all pumps
2. Dirty filter indication
3. Oil tank levels (generators)
4. Oil tank over fill alarm (generators)
5. Oil tank fire valve (generators)
6. Generators oil fire valve
7. Generator faults and status
8. Fire alarm status via each starter panel
9. Smoke management systems status and alarms
10. Fire-fighters H/O/A extract switches
11. Smoke control systems status and alarms
12. Frost protection trace heating
13. Gas safety systems associated with the LTHW boilers plant and catering supplies
14. Gas fire suppression/extinguisher system status/alarms.
15. Air Sampling (Smoke) warning

Alarm Only
1. High temperature within transformer rooms and LV switch rooms
2. Petrol Interceptor alarms

Record
1. All temperature and humidity conditions, including external
2. Hours run for plant items
3. Gas, electric and water consumption
4. Faults
5. High and low limit conditions

Instigate
1. Pre-set routines in event of mains failure
2. Pre-set routines in event of fire (signal from fire alarm system direct or via starter panel)

Section 6000000 – Electrical engineering services

6201000 Containment systems

6201001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

6201002 Cable ladder rack

Cable ladder rack shall be installed where required for the support and accommodation of larger cable systems.

The rack shall be of proprietary manufacture, from a recognised company and shall be a complete system, with all fittings etc. The material and finish shall be glavanised steel.

Site manufactured fittings will not be accepted.

The rack shall be sized to accommodate all necessary cables,allowing space between cables and having due regard for grouping and cable current ratings.

The rack shall be installed as a complete system and supported as detailed on drawings using steel channel and fixing clips, brackets, etc. The channel and fixings shall be of the same finish as the rack. Where the finish has been damaged during erection, it shall be repaired or touched up with a paint system to match the original finish.

Supports are to be designed to take the full weight of the rack and cables, along with any imposed loads such as wind etc and imposed loads produced during installation and cable pulling. When the rack is finally installed and loaded, deflection between supports shall not exceed the manufacturers' recommendation.

6201003 Perforated cable tray

General
Perforated cable tray shall be formed from plain steel sheet which has been hot dip galvanised after fabrication to BS EN ISO 1461, unless otherwise specified. Tray shall have a minimum coating weight of 275 g/m2.

Cable tray shall have the dimensions and finish as specified on drawings or in associated particular information.

Standard Dimensions of Cable Tray

Nominal Width	Minimum Height of Upstand	Nominal Thickness of Steel Sheet	Application
100mm	12mm	1mm	Internal
150mm	12mm	1mm	Internal
225mm	12mm	1.5mm	Internal
300mm	20mm	1.5mm	Internal
450mm	20mm	1.5mm	Internal
600mm	20mm	1.5mm	Internal
100mm	12mm	2.5mm	External
150mm	12mm	2.5mm	External
300mm	20mm	2.5mm	External

Bends and Tees
Bends shall be of the same material, thickness and finish as the cable tray and shall have an inner radius of 50mm and a straight length of 100mm at each end.

No perforations shall be made in the circular portion of the 100mm and 150mm bends. On 225mm and 300mm bends perforations shall be made only a line set at 45º. On 450 and 600mm bends perforations shall be made only along lines set at 30º and 60º.

Tees shall be of the same material, thickness and finish as the cable tray. The distance measured between a point of intersection and at the end of the fitting shall be 100mm.

Fixing Screws
Mushroom-head steel roofing bolts and nuts complying with BS 1494 Part 1 shall be used to fix together adjacent sections of cable tray and/or accessories. The head of any fixing screw shall be presented to the surface of the tray on which the cables are to be fixed.

Installation
Cable tray shall only be cut along a line of plain metal, ie not through the perforations. All cut edges of galvanised cable tray shall be prepared and treated with 2 coats of a zinc rich paint.

Site fabrication of accessories shall be kept to a minimum and manufacturers' standard items shall be used. Where special sections are required, the material, thickness and finish shall be as specified for standard items.

Where welding has been employed in the fabrication of cable tray and/or accessories the area around the joint shall be mechanically prepared and thereafter treated with zinc chromate primer or zinc rich paint according to the original finish of the metal.

Holes cut in cable tray for the passage of cables shall be provided with securely fixed bushes.

A minimum clear space of 20mm shall be left behind all cable tray.

Fixings for cable tray shall be disposed at regular intervals not exceeding 1200mm and at 225mm from bends, tees and intersections. The maximum deflection between supports on a fully loaded cable tray shall not exceed 1/110 of the span between supports.

Fixings shall be fabricated from mild steel flat bar. When used with galvanised cable tray, fixings shall be hot-dip galvanised, unless only bending and drilling is required in the manufacture when galvanised mild steel flat bar may be used. Hot-dip galvanising shall comply with BS EN ISO 1461.

6201004 Cable basket

Cable basket shall be manufactured from electro plated zinc steel wire and shall be supplied with all associated accessories.

Cuts in cable basket shall be carried out with the manufacturers recommended tools. Cut sections to create bends, tees etc, shall be bolted together such that the structural rigidity shall be the same as for a manufactured section.

Where bends in cable basket are formed on site, the radius of those bends or tees shall be sized to accommodate twice the largest installed cable.

Where cable basket is used to carry cables such as Cat 5e, Cat 6, Cat 6a, or any other gigabit speed IT cabling, the basket shall be lined with a suitable barrier to prevent cable compression.

Cable basket shall not be used in external environments or where extremes of temperature and moisture may be present.

Only proprietary fixings designed specifically for use on cable basket shall be used.
A minimum clear space of 20mm shall be left behind all cable basket.

Support system fixings for cable basket shall be at distance no greater than 1200mm apart and at 225mm from bends, tees and intersections. The maximum deflection between supports on a fully loaded cable tray shall not exceed 1/110 of the span between supports.

The support system shall be fabricated from mild steel flat bar or channel.

6201005 Steel trunking

Steel trunking shall mean general service trunking, multi compartment trunking, lighting trunking, dado and skirting trunking and floor trunking. Where necessary, specific requirements are given in associated particular requirements.

Unless otherwise specified the whole of the various installations specified herein shall be carried out in galvanised steel trunking complying BS EN 50085.

Underfloor and flush floor trunking shall comply with BS 4678-2

General trunking shall be the return flange type.

All trunking shall be supplied with appropriate screw fixed lid. Where security fixings are required, they shall be identified elsewhere in this specification. Verify type of security screws before procurement.

Lighting trunking shall only be used for its intended purpose and shall be supported in accordance with it's manufacturers recommendations. Galvanised lid shall be installed unless the CA accepts the use of plastic lid.

The trunking installation shall be suitable for the environment and be protected against corrosive or polluting substances, extremes of temperature and excessive solar radiation.

Only manufactured bends, tees, intersections, stop ends, hangers, joints and all other fittings shall be used. No site or workshop fabricated fittings or accessories shall be permitted. Ensure fittings are the same class and finish as associated trunking system

Inverted trunking, including lighting trunking shall be supplied with cable restrainers.

Where but joints are made in trunking runs, these shall be fully supported so that the joint is not subjected to strain.

Where conduits terminate into trunking, this shall be via a brass bush and coupling.

As soon as galvanised trunking is fixed in position all exposed cuts and scratches shall be painted with one coat of zinc rich paint.

All trunkings shall be checked for debris before wiring is commenced and cables shall not be drawn into any section of the system until the system is complete.

All joints shall be fitted with copper bonding links.

All bolts shall be installed so that no cables can snag on them.

Where cables leave the trunking system, a suitable edge protection shall be provided to stop cuts and abrasion of cables.

Trunking shall be supported at regular intervals not exceeding 1.2m on horizontal runs and 1.5m on vertical runs. Where the trunking manufacturers recommendations are more onerous, they shall be applied instead of the distances given above.

Accessories such as switch boxes and adaptable boxes shall be connected to the trunking system via couplings and bushes.

6201006 PVC and uPVC Trunking

PVC trunking shall mean general service trunking, "mini" trunking, multi compartment trunking, dado and skirting trunking as well as PVC floor trunking. Where necessary, specific requirements are given in associated particular requirements.

Unless otherwise specified the whole of the various uPVC trunking installations shall be carried out with products manufacturered to BS 4678-4.

Trunking shall be supplied form one source so that variations in colour are avoided.

Lighting trunking shall only be used for its intended purpose and shall be supported in accordance with the manufacturers recommendations.

The trunking installation shall be suitable for the environment and be protected against corrosive or polluting substances, extremes of temperature and excessive solar radiation.

Only manufactured bends, tees, intersections, stop ends, hangers, joints and all other fittings shall be used. No site or workshop fabricated fittings or accessories shall be permitted. Ensure fittings are the same class and finish as associated trunking system. No joints cut with hacksaws shall be permitted.

Inverted trunking, including lighting trunking shall be supplied with cable restrainers.

Where but joints are made in trunking runs, these shall be fully supported so that the joint is not subjected to strain.

Where conduits terminate into trunking, this shall be via a uPVC bush and coupling.

Any sections with scratches or abrasions in the trunking shall be replaced by the contractor.

Conduit which has manufacturers or distributors codes marks or other information either stamped or printed on it shall not be used.

All trunkings shall be checked for debris before wiring is commenced and cables shall not be drawn into any section of the system until the system is complete.

Where cables leave the trunking system, a suitable edge protection shall be provided to stop cuts and abrasion of cables.

Trunking shall be supported at regular intervals not exceeding manufacturer's recommendations

6201007 Steel conduit

Unless otherwise specified the whole of the various installations specified herein shall be carried out in heavy gauge galvanised screwed conduit complying the BS 4568 Parts 1, BS EN 50086 and BS EN 61386.

Resistance to ingress of water and against ingress of solid foreign bodies shall be to the stated rating to BS EN 60529.

The conduit installation shall be suitable for the environment and be protected against corrosive or polluting substances and excessive solar radiation.

Ensure fittings are the same class and finish as associated conduit system

No conduit less than 20mm diameter or larger that 32mm diameter will be permitted.

The end of conduits shall be cut square and the length of screw threads shall be sufficient only to allow the ends of the conduit to butt solidly in all couplings and against the shoulders provided in conduit boxes.

The ends of all conduits shall be carefully reamed to remove all burrs or sharp edges after the screw threads have been cut. All dirt, paint or oil on the screwed threads of the conduit and accessories shall be carefully removed immediately prior to erection.

The number of running joints in conduit shall be kept to a minimum and where installed locknuts shall be used to secure the sockets.

Where conduits terminate in switch-fuses, fuse-boards, adaptable boxes, etc., they shall be connected thereto by means of smooth bore male brass bushes, compression washers and sockets. Where a conduit terminates on a sheet steel enclosure a flanged coupler shall be used.

All bends are to be made on site to suit conditions and not more than two right angle bends or runs exceeding 15 metres will be permitted without the interposition of a draw box. No tees, elbows, sleeves, either of solid or inspection type will be permitted.

Immediately conduits are fixed in position all exposed threads, scratches and bends shall be painted with one coat of zinc rich paint.

All conduits shall be swabbed through before wiring is commenced and cables shall not be drawn into any section of the system until all conduits and draw boxes for that particular section are fixed in position.

All conduits shall be concealed unless specifically indicated otherwise, i.e. in roof spaces, above suspended ceilings, under floors, in flooring screeds, cast insitu, and in chases cut or cast into walls and/or concrete ceilings.

Where a concealed installation is called for, all conduits shall be chased into walls and concealed in the ceilings and floor screeds as far as the structure of the building will permit. Conduits installed in chases shall be fixed by means of crampets and painted 2 coats bitumastic paint prior to the chases being filled in.

Deep boxes or extension rings on standard circular conduit boxes shall be used where necessary in order to bring the front face of each box flush with the surface of the ceilings and walls.

Conduit runs shall be determined by the installer and approved before any work is started. Conduit shall be run at least 150mm clear of plumbing and mechanical services.

Conduit runs shall be planned to obviate the need for draw-in-boxes, but where the use of them is unavoidable they shall be accessible at all times and be fitted with covers.

Conduit run on the surface shall be run vertical, horizontal or parallel with the features of the building.

Conduit buried in concrete shall have at least 35mm depth of cover over its entire length. Conduit buried in plaster shall have at least 5mm depth of cover over its entire length.

Where conduit is buried in the carcass of a building or in the ground, all open ends shall be temporarily plugged or wrapped in ‘Denso’ tape to prevent ingress of foreign matter, moisture or water.

Where conduit buried in concrete crosses an expansion joint in the concrete, it shall be wrapped with ‘Denso’ tape for a distance of 300mm on each side of the joint. The coupling method for protecting the conduit against stresses due to expansion shall be approved by the CA.

Conduit shall be supported at regular intervals not exceeding 1.2m on horizontal runs and 1.5m on vertical runs. On surface runs, any section of conduit run shall be supported by at least two saddles and shall not rely on the integrity of any conduit box or connection to any other containment or accessory for support.

At each distribution board and multi-gang switchbox the conduit provided must be of the capacity to accept all cables, which could be connected to outgoing ways, whether they are installed at this stage or in the future.

Conduit systems shall be sized in accordance with the details given in Appendix A of Guidance Note No. 1 published by the IET. The cable capacities given in this document shall not be exceeded (note that protective conductors can be ignored in capacity calculations, so long as cables can be easily installed and removed).

Wire pulling lubricant shall not be used. The CA reserves the right to require all cables pulled in with any lubricant to be removed and replaced and conduits cleaned out.

Where surface conduit is specified, it shall be fixed by means of distance saddles and shall terminate in deep pattern conduit boxes. Surface conduits shall not be bent or cut to enter

accessories. If a suitable accessory is not obtainable, the accessory shall be mounted on an approved backing piece of sufficient thickness to align the conduit entry with the surface conduit

6201008 Steel Adaptable Boxes

All draw boxes and junction boxes shall be of ample size to permit the cables to be drawn in and out. They shall be of sheet steel and shall be of square or rectangular pattern. Circular draw-in or junction boxes shall not be used. At all lighting points and switch points, the conduit shall terminate in suitable boxes provided with internal lugs to permit the back plates of the fittings or switches to be attached to them by metal threaded screws.

In damp situations, box lids must be fitted with rubber gaskets and external boxes must be filled with non-setting cold plastic compound.

All spare ways in junction boxes, etc., left for future extensions shall be fitted with brass stopping plugs.

Adaptable box minimum size shall be 100mm x 100mm x 50mm unless otherwise indicated.

Connections to motors and appliances

Conduit shall not be connected direct to a motor, or other appliance liable to vibration, but shall terminate in a through type conduit box or adaptable box at a convenient position adjacent to the motor.

The cable shall be continued in a short length of flexible metallic conduit or composite PVC/metal foil conduit that shall be fixed to the motor terminal box.

An independent stranded copper cable protective conductor shall be run through all such flexible conduit and shall be connected to the motor earth terminal at one end and to a M 3.5 screw tapped into the side of the connected box at the other. The cable is to be sized in accordance with the requirements of BS 7671.

6201009 Condensation management in steel conduit installations

Install conduit systems to ensure internal condensation does not affect the operation of associated circuits. Provide drainage points in accordance with BS 7671.

Where conduit passes through external wall between two areas of different ambient temperatures or in other locations likely to cause condensation, install a conduit or adaptable box. After wiring fill box with inert, permanently plastic compound with high insulation value.

6201010 PVC Conduits and Accessories

All PVC conduits shall be high impact PVC complying with BS 4607, BS EN 50086 and BS EN 61386. The minimum size of conduit shall be 20mm external diameter.

PVC conduit which has manufacturers or distributors codes, marks or other information either stamped or printed on it shall not be used.

Light gauge conduit may be used for protected pre-cast and in-situ concrete work where builders' traffic is minimal.

Heavy gauge conduit shall be used for surface installation and where it is laid in floor screeds.

Conduits shall be jointed and terminated utilising the appropriate rigid PVC components detailed below or standard conduit entry electrical equipment. Jointing will conform to one of the following techniques:
Permanent Adhesive
The solvent cement supplied by the conduit manufacturer shall be used to produce a rigid sealed connection.

Flexible Adhesive
A non-hardening adhesive supplied by the conduit manufacturer shall be used to produce a flexible sealed joint where allowance is necessary for longitudinal movement (e.g. expansion couplers).

Bends and sets in conduit will be made in accordance with the manufacturers' instructions. The radius of the bend shall not be less than 2.5 times the outside diameter of the conduit or such greater radius that will facilitate easy drawing-in of cables.

PVC conduits shall not be used in situations where ambient temperatures are likely to exceed 70ºC or where the normal working temperature of conduits and fittings will exceed 60ºC. Conduits shall not be installed adjacent to steam or hot water pipes. Adequate allowance shall be made for longitudinal expansion and contraction of the conduits under normal working temperature variations as follows:

Expansion couplers should be used on straight runs exceeding 6.0m with a loose or flexible type joint (b above) at the long spout end of the coupler. Special consideration shall be given to the fixing of accessories where this may prevent natural conduit movements. Oversize or slotted fixing holes may be necessary or the introduction of expansion couplers.

Conduits shall be saddled at not more than one metre intervals.

6201011 PVC Conduit Boxes

PVC adaptable boxes shall be of moulded or fabricated PVC of square or oblong shape complete with PVC lids secured by two M4 round or pan headed screws. All adaptable boxes and lids of the same size shall be interchangeable. No adaptable box smaller than 75 x 50mm or larger than 300 x 300mm shall be employed. Boxes shall be of adequate depth in relation to the size of conduit entering them.

Conduit shall be terminated at adaptable boxes, fuseboards, switches, socket-outlet or other equipment not possessing push-in or threaded spouts by means of the appropriate size adaptors. All cemented joints are to be made to a depth not less than the diameter of the conduit being used.

6201012 Protective conductors in PVC trunking and conduit

A separate circuit protective conductor shall be provided within non-metallic conduits and trunking. The conductor shall have green/yellow LSF insulation and shall be sized in accordance with the requirements of BS 7671. A protective conductor may be common to more than one final circuit providing it is sized for the worst circuit conditions.

An earthing terminal shall be provided at every switch and outlet position for connection of a circuit protective conductor as required.

6201013 Excavation and laying of cables, external

Underground cables shall be laid direct in trenches unless otherwise indicated.

When cable trenches are opened all cables shall be laid and the trenches shall be backfilled within 24 hours. At all times adequate safety precautions shall be taken around open trenches and arrangements made to prevent damage to cables.

Trenches shall be excavated to provide the minimum cover specified elsewhere. Turf and topsoil and any reusable paving/sets etc shall be removed carefully and preserved for reinstatement in their original positions.

Minimum cover for cables

Cables shall be covered to a minimum depth as given in the NJUG standard Volume 1.

Where damage is caused during excavation to drainage and other services, this shall be reported immediately to the CA. Approval shall be obtained from the CA before backfilling the trench.

The excavation shall be kept free of water and properly shored up in a manner pre- approved by the CA. Other services uncovered shall be adequately supported by slings or other means and protected.

Before cables are laid, the bottom of the trench shall be evenly graded, cleared of loose stones and then covered with a 75mm layer of sand.

Power cables shall be pulled in over adequately spaced cable rollers and the resulting surplus cable shall be snaked across the width of the trench. In straight run trenches cable crossing is not permitted except where cables branch from the main run. At each draw-in point, joint or junction box the cable shall be left slack. Cables shall not be pulled taught to straighten them after laying.

Cables stockings shall be used for cable hauling. In order to ensure that the strain is taken on the cores as well as the sheath when cables are laid with a cable stocking, a solid plumbed hauling end shall be made. The only permissible exceptions to this requirement are the lengths of up to 9 metres not pulled into a thrust boxing.

Where more than one cable is laid in a trench the cables shall be spaced apart in accordance with their current rating but subject to the minimum spacing specified elsewhere. The minimum distance between cables and segregation from other services shall be as specified elsewhere. When this is not possible 50mm thick concrete or stone tiles shall be used as separators.

Minimum spacing of cables

Cable type	HV	LV	Telephone	Co-axial	Gas, Water and other piped services
	mm	mm	mm	mm	mm
HV	50	300	300	300	300
LV	300	25	150	150	300
Telephone	300	150	50	50	250

After laying, the cables shall be covered with sand to ensure a 50mm cover after tamping. Warning covers as specified shall be laid over the cables and the trench filled in and compacted. Cable warning marker tape shall be laid across the full width of the trench at 100mm below finished ground level (see clause 2.3.14 and table 3E for colour details.)

Reinstatement shall be effected by backfilling in 100mm layers and hand ramming the first two layers. Power compactors may be used for the remaining layers. The turf, slabs, etc shall be replaced and the level of the finished reinstatement shall not protrude more than 25mm above the normal ground level. All soils shall be properly compacted and where required by the CA, a compaction test shall be carried out in accordance with the method set out in BS 1377: Part 9, 1990.

All cable ends shall be sealed in a manner recommended by the cable manufacturer.

6201014 Cable warning covers

Interlocking cable warning covers shall be provided for cables laid direct in the ground. The material and dimensions of the covers shall be as specified on drawings.

The location of all directly buried cables shall be marked by concrete slab markers, 600mm square and 100mm thick.

Each HV and LV cable run shall be marked at the point where it leaves the plinth, sub-station, feeder pillar or other current controlling device, and shall be marked at approximately every

60 metres along the cable run with an additional marker at each change of direction of the cable run.

Cable markers shall be installed flat in the ground immediately above the cable with approximately 25mm projecting above the surface. When site fabricated, impress the words 'HV CABLE' or 'LV CABLE' together with a cable reference number as required on each cable marking slab. The letters shall be approximately 100mm high and 75mm wide overall with strokes 12.5mm wide and 6mm deep.

Cable Warning Covers

Service	Material for Cover	Number and Diameter of Cables	Dimensions of cover (length & width)
LV	Earthenware	One not exceeding 50mm One exceeding 50mm or two not exceeding 37.5mm	225 x 150mm 300 x 225mm
HV	Reinforced concrete	One not exceeding 50mm One exceeding 50mm	1m x 150mm 1m x 175mm

The location of each underground cable joint shall be marked by a concrete slab placed over the joint with approximately 25mm of slab projecting above the ground. When site fabricated the word 'JOINT' shall be impressed by the installer on each slab in letters approximately 100mm high and 75mm wide overall with strokes 12.5mm wide and 6mm deep. Joint locations shall also be precisely located on as build drawings, dimensioned from some easily identifiable fixed point on the building.

6201015 Cable ducts and draw pits

All cable ducts shall be formed from 100 or 150 diameter uPVC piping, as detailed elsewhere. Ducts shall be laid in continuous lengths with integral joints and shall form a watertight system to prevent the entry of ground water into the duct system (this watertight requirement is not applicable to short ducts for road crossings).

Ducts shall be uPVC to BS EN 1401, complete with vehicle loads, encasement, concrete and draw pits, fittings, etc to make a composite system. All duct routes shall be shown on the installers drawings and agreed on site with the CA prior to installation.

Cable ducts shall only each contain one distribution cable (with any associated pilot or control cables), but for systems such as street lighting etc, multiple cables may be drawn into a duct, so long as the cables do not take up more than 30% of the duct section, the cables can easily be withdrawn and the effect of grouping is allowed for in the current rating of the cables.

All duct and tape colours and identification shall comply with the proposals set out by the National Joint Utilities Group (NJUG). Table 1 in NJUG publication “Guidelines on the positioning and colour coding of underground utilities’ apparatus” details the specific requirements

The NJUG code is not retrospective and older installations installed before the code was adopted may not conform to the current colour scheme.

Cables installed on private property may not follow the guidelines in this document. The owner concerned should be contacted for information on the colour code applying in these cases.

Abandoned ducts are sometimes used for other purposes. Ensure systems are fully identified and traced out before any work is carried out.

Ducts shall be laid to be self-draining to the cable pits and a drainage connection shall be made to the surface water drainage system.

Ducts shall be kept clear of gas and water pipes, drains, sewers and electrical plant. In order to allow the use of ‘tapping’ machines on gas and water mains that may be adjacent wherever possible at least 150mm clearance shall be given to these and any other services. No

clearance shall be less than 25mm where services cross, the minimum clearance shall be 50mm.

Ducts shall be laid to provide the minimum cover and spacing specified.

Where it is necessary to deflect from a straight line or to vary the depth, as in passing from footway to carriageway or in entering an underground chamber, a lateral set not exceeding 25mm in a length of 750mm or a vertical set not exceeding 25mm in a length of 1.5 metres shall be given to the joints.

Ducts shall be plugged or capped before and after each test. uPVC plugs or caps shall be inserted at the ends of each section of duct to prevent entry of soil or stones.

Ducts shall be cleared in the presence of the CA with a mandrel not smaller than the internal diameter of the duct minus 12.5mm followed by a circular wire brush 12.5mm greater in diameter than the duct just before any cables are drawn in.

6201016 Sealing of duct entries to buildings (including service pipes)

After all cables have been installed, both duct ends shall be sealed using mastic or expanding foam to form a vermin, gas, water and fire barrier. The fire rating of the seal shall be as necessary to match the fire rating of the local building structure.

Spare ducts shall be sealed with end caps and mastic to form a vermin, gas, water and fire barrier.

Cables shall be identified where they come into and out of ducts and all labels shall be legible and visible after duct sealing is complete.

6202000 Cabling systems
6202001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All cables shall be colour coded in accordance with the requirements of BS 7671 (taking account of the latest revisions regarding colour compliance. If the contractor is in any doubt as to the colour coding required, particularly with the installation of new cabling within an existing building, then the installer shall seek written confirmation from the CA).

Low-voltage cables shall have a voltage designation as shown below:

Cable type	Standard designation	Voltage rating
PVC insulated and unsheathed	6491X	450/750V
PVC insulated and sheathed	6241Y	300/500V
PVC insulated and sheathed	6242Y	300/500V
PVC insulated and sheathed	6243Y	300/500V
PVC insulated and sheathed	6181Y	300/500V
LSOH insulated and unsheathed	6491B	450/750V
LSOH insulated and sheathed	6242B	300/500V
LSOH insulated and sheathed	6243B	300/500V
PVC insulated and sheathed	3182Y	300/500V
PVC insulated and sheathed	3183Y	300/500V
PVC insulated and sheathed	3184Y	300/500V
LSOH insulated and sheathed	3182B	300/500V
LSOH insulated and sheathed	3183B	300/500V
LSOH insulated and sheathed	3184B	300/500V
PVC insulated, single wired armoured, PVC sheathed	6942X (PVC/SWA/PVC)	600/1000V
PVC insulated, single wired armoured, PVC sheathed	6943X (PVC/SWA/PVC)	600/1000V
PVC insulated, single wired armoured, PVC sheathed	6944X (PVC/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, PVC sheathed	(XLPE/SWA/PVC)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6942B (XLPE/SWA/LSF)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6943B (XLPE/SWA/LSF)	600/1000V
XLPE insulated, single wired armoured, LSF sheathed	6944B (XLPE/SWA/LSF)	600/1000V

Abbreviations:
1. PVC – Polyvinylchloride
2. LSOH – Low smoke and zero halogen
3. LSF – Low smoke and fume
4. XLPE – Cross linked polyethylene

Notes:
1. PVC insulated as well as PVC insulated and sheathed cables shall not generally be used.
2. PVC insulated, single wire armoured, PVC sheathed cables shall only be used where cables are either buried in the ground or contained in ducts likely to be saturated with water.
3. LSOH shall mean low smoke cables which burn with zero halogen content and shall not limit the contractor to using Prysmian cables.

Reduced neutral conductors in multicore cables are not acceptable. Conductors shall be copper unless otherwise specified.

CY, SY and YY type cables shall only be allowed where verifiable cable data stating current (A) rating in appropriate scenarios, thermal constraints applying to that rating, volt drop in mV/A/m and conductor resistance in ohms/km is available before installation.

Comply with the requirements of Regulation 522.6.6, 522.6.7 and 522.6.8 with regard to cables concealed in walls or partitions. In addition to requirements elsewhere in this specification, unskilled labour shall not be permitted for cable installations.

Note: PVC conduit shall not be accepted under Regulation 522.6.6 (iv)…

"*be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws"*

…as a suitable method of providing mechanical protection under this contract unless agreed with the client during the tender period.

The contractor shall not make any assumptions as to whether or not a buildings electrical installation will be under the control of a skilled or instructed person once in use.

All cables shall be of one manufacture only and shall be delivered to site with appropriate seals if the cable is likely to suffer from water or frost damage. Where cables are supplied on drums, stored for long periods and subject to extremes of temperature, the cables shall be uncoiled and stored in a manner which eliminates the risk of thermal damage to the insulation.

Labels on cable drums shall indicate the manufacturers name, size, description, BS number, classification, length, grade and date of manufacture.

All cable types shall be certified and marked in accordance with the British Approvals Service for Electric Cables (BASEC)

Records shall be kept of all high-voltage cable drum numbers and supporting information. This information shall be indicated on the record drawings indicating the precise location of each length of cable.

Copies of the manufacturer's cable test certificates shall be included in the operating and maintenance manual.

Where conductor sizes are not indicated in the specification and/or the associated drawing(s) they shall be selected in accordance with BS 7671 for the current rating required by the circuit loading, the type of cable, the ambient temperature, the conditions of installation and the maximum voltage drop permissible.

6202002 Unarmoured cables

PVC and LSOH insulated and unsheathed cables drawn into conduit and trunking

LSOH insulated cables shall be manufactured to BS 7211. PVC insulated cables shall be manufactured to BS 6004.

Cables shall only be drawn into a conduit system when it is complete, permanently fixed and thoroughly swabbed out.

The cables shall be looped progressively from point to point and joints will not be permitted. Cables for different voltage bands shall not be installed in the same conduit and trunking systems unless specifically stated in project particular information.

The installation of cables in any conduit shall be in accordance with manufacturers' instructions and BS 7671. Cables shall be installed in conduit and trunking in accordance with IET guidance; however cables in conduit shall occupy no more than 65% of the available space and in trunking, no more than 55%.

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Cables shall be drawn in such a manner that it is possible to withdraw any number from the conduit without disturbing the remainder. Wire pulling lubricant shall not be used.

The CA reserves the right to require all cables pulled in with any lubricant to be removed and replaced and conduits cleaned internally.

PVC and LSOH insulated and sheathed cables

Insulated and sheathed cables shall be installed on either cable tray, cable basket or trunking. Cables may also be clipped direct to building fabric as well as concealed within the building fabric in accordance with BS 7671.

Please note that where concealed in the building fabric, the depth of cables and method of mechanical protection may introduce the need to protect the circuit by either RCD or RCBO.

The installation of cables shall be in accordance with manufacturer's instructions and BS 7671.

6202003 Armoured cables

1. XLPE/SWA/PVC cables shall be manufactured to BS 5467.
2. PVC/SWA/PVC cables shall be manufactured to BS 6346.
3. XLPE/SWA/LSF cables shall be manufactured to BS 6724

The armouring for multi-core cables shall consist of a single layer of galvanised steel wires complying with BS EN 10257-1. Single core cables shall have non-magnetic armour, such as aluminium wire or strip.

Where cables are buried direct in the ground or laid in ducts, they shall be installed and covered in accordance with the National Joint Utilities Group (NJUG) Standard Volume 1.

Where cables are installed on cable ladder, tray, basket or fixed directly to the building fabric, they shall be securely fixed in accordance with BS 7671. Where cables are exposed to direct sunlight or extremes of temperature, they shall be provided with suitable containment or solar shading as appropriate.

6202004 Flexible cables and cords

All flexible cables shall comply with BS 6500 and shall be 450/750V grade PVC insulated and sheathed in normal temperature situations, with various other insulation and sheath properties in 300/600V grade to BS 6141 for higher operating temperatures. The minimum conductor size shall be 1.0mm2.

In addition to those flexible cable types listed under general requirements, the following flexible cables and cords may be used in the appropriate situation and subject to authorisation by the CA.

1. 60°C rubber insulated braided twin and three core.
2. 60°C rubber insulated and sheathed.
3. 60°C rubber insulated oil-resisting and flame retardant sheath.
4. 85°C rubber insulated HOFR sheathed.
5. 85°C heat resisting PVC insulated and sheathed.
6. 150°C rubber insulated and braided.
7. 185°C glass fibre insulated single core twisted twin and three core

The application of the above temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature.

Where an earthing conductor is required for the earthing of metalwork in apparatus and luminaires, it shall be contained within the flexible cord.

Flexible cords for use with lighting pendants and electric lighting fittings

All flexible cables and cords shall comply with BS 6500 and BS 6004. Cables shall be 300/500V grade PVC, rubber or LSF insulated and sheathed as appropriate.

Flexible cords for use with luminaires employing tubular fluorescent lamps or apparatus operating at normal room temperature shall be PVC insulated and sheathed and shall comply with BS6500.

The application of the temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature.

Where an earthing conductor is required for the earthing of metalwork in apparatus, it shall be contained within the flexible cable or cord.

Flexible cables and cords shall be secured at each end with proprietary retaining clamps.

6202005 Mineral insulated cables (MICS)

MICS cables shall comply with BS EN 60702 and be either LSF sheathed or bare copper as specified elsewhere in this document.

All persons employed to make terminations on MICS cables shall have attended a course of instruction and they shall demonstrate, if so requested, to the CA their ability to make a satisfactory seal prior to commencing work on the site.

Where terminations are made to flush accessory boxes within a plaster finish cable clamps fixed to the accessory box and firmly gripping the cable seal may be used in lieu of the brass gland.

Where glands are terminated in equipment without screwed entries, a lock washer and back nut shall be used.

Where cables are exposed, shrouds shall be fitted over the glands. These shrouds shall be the same colour as the sheath.

All circuits with inductive loads supplied by MICS/LSF cabling shall be fitted with voltage surge suppressors in accordance with the manufacturer's recommendations.

Jointing
If a run of MICS cable is of a length that exceeds the maximum to which the cable can be manufactured, a through joint will be permitted. Such a joint shall be made with an adaptable box into which shall be fitted a fixed base mechanical clamp type connector of approved design.

Installation
Where MICS cables are not installed on cable tray they shall be fixed by either bare or LSF coated copper clips (as appropriate to the type of cable) of an approved design at a maximum of 375mm centres on vertical runs and a maximum of 200mm centres on horizontal runs.

Where MICS cables pass through floor slabs or other structural work, they shall be protected by short pieces of heavy gauge galvanised steel conduit. The conduit shall be plugged with non-setting cold mastic compound after the MICS cables have been installed.

Where MICC cables without LSF outer sheath run across or pass in close proximity to steel or other conducting building material, water pipes etc the cable shall be bonded to the said materials at intervals to ensure that no difference in potential can exist. Spacing saddles shall be installed to prevent the cables from contact with dissimilar metals.

All cables shall be installed in a neat and workmanlike manner, being dressed into shape and free from corrugations and damage to the sheaths. All cables shall run vertically on walls and at right angles or parallel to floors of the room or areas served. On no account shall diagonal or arbitrary routes be permitted.

Minor runs of not more than two MICS cables may be fixed direct to non-fireproofed structures, masonry and concrete. In all other situations, they shall be run on cable tray.

Multiple runs of MICS shall be laid neatly on perforated cable tray of an approved type, spaced from the tray by multiple fixing cleats recommended by the manufacturer.

All cable routes shall be agreed by the CA before work is started. Cables shall be run at least 150mm clear of all plumbing and mechanical services. The use of conduit and/or cable trunking to enclose conductors shall be kept to the minimum.

Where an MICS cable is connected to a motor or other appliance liable to vibration, the cable shall be taken direct to the terminal box. A coil of one turn to a radius of not less than 100mm shall be formed in the cable to take up their relative movement between the machine and the solid base.

6202006 Soft skin fire performance cables

Soft skin fire performance cables are those types capable of continuing to operate when exposed to fire. All soft skin cables used on the project shall comply with BS 7629 and BS EN 50200. All cables shall have insulation complying with BS 7655 to standard EI5.

Where cables using solid inner cores are used, these cables shall be installed without kinks. Any kinked cables shall be replaced throughout their length.

Each termination shall be complete with suitable gland and shroud.

Where cables are used for fire alarm installations, the colour shall be agreed with the CA prior to commencing any installation. Do not assume that red sheathed cables will be accepted.

Cables shall be supplied by the same manufacturer throughout the project when used on a common system.

Care shall be taken when terminating soft skin cables to ensure cores are not compressed together

6202007 ELV cables for data and communication use

Cables for data and communications use shall be in accordance with the operational requirements of the system to which they are installed. Where cables run in the proximity of LV cables, they shall have insulation to the same standard.

Where ELV cables are installed in areas of high moisture, extremes of temperature or exposed to direct sunlight, they shall be protected by suitable containment.

All cables shall be installed in accordance with BS 7671.

6202008 Cable installation & support

Cable support intervals

All distribution and final circuit cabling shall be supported on a cable support system complying with the manufacturers recommendations. Where no recommendations are available, support at the following maximum intervals (dimensions in millimetres) may be acceptable as agreed with the CA.

Cables conforming to BS 6346, BS 5467 and BS 6724:

Overall cable diameter not greater than	Non-armoured Vertical	Horizontal	Armoured Vertical	Horizontal
9	400	250	400	250
9 to 15	400	300	450	350
15 to 20	450	350	550	400
20 to 40	550	400	600	450
40 to 60	900	700	900	700
60 upwards	1100	1100	1300	1100

Cables conforming to BS EN 60702:

Overall cable diameter not greater than	Horizontal	Vertical
9	600	800
9 to 15	900	1200
15 to 20	1500	2000

Cable Bending Radii

Cables conforming to BS 6346, BS 5467, BS 6724 and BS EN 60702 shall have the following minimum internal bending radii, unless the manufacturer specifies some greater radius.

Insulation	Finish	Overall Diameter	Multiplying Factor for Minimum Bending Radii
Rubber, PVC or XLPE circular or circular stranded copper or aluminium conductors	Non armoured	up to 10 10 to 25 25 and above	3 4 6
	Armoured	all	6
PVC or XLPE solid aluminium or shaped copper conductors lifts 2000V	Armoured or non-armoured	all	8
XLPE insulated above 2000V	Armoured	all	12
Mineral	Copper with or without PVC or LSOH sheath	all	6

6202009 Cable glands

All cable glands and terminations shall maintain the IP rating and integrity of the enclosure they terminate into. Unless otherwise specified elsewhere, mechanical cable glands shall be brass to BS 6121. Where proprietary forms of gland made of nylon or similar plastics material are available, they may be used with unarmoured cables.

Indoor glands shall be BS 6121 type CW and outdoor glands type E1W minimum. All glands shall be fitted with close fitting shrouds of the same colour as the cable sheath.

All cables shall be identified at each gland and termination as specified elsewhere.

6202010 Cable jointing and terminations

All joints and terminations shall be made by qualified cable jointers, using jointing materials, components and workmanship recommended by the cable manufacturer and jointing accessory manufacturer. The manufacturers, instructions shall be followed at all times.

Cable ends shall be cut immediately prior to jointing or terminating. Cables left unconnected for more than 24 hours shall be sealed to permanently prevent the ingress of moisture. All XLPE and LSF sheathed cables shall be sealed using proprietary shrink on end caps.

All necessary precautions shall be taken to ensure that strands are not damaged when stripping cable cores. Strands shall be twisted together and mechanically secured at terminations. Under no circumstances shall the number of strands be reduced at any termination.

Prior to jointing or terminating, the armour of all armoured cables shall be cleaned.

Where connections are made to equipment and switchgear without integral cable clamping terminals, insulated compression lugs shall be used for bolted terminal connections.

For core sizes 10mm2 and above, all compression connections to components shall be made using tools that cannot be released unless the correct degree of compression has been achieved.

Core terminations shall be securely bolted via lugs to equipment using washers and proprietary shake-proof devices.

The bunching of more than two cores at clamping terminals or bolted connections shall not be permitted.

All cables shall be marked at each end at both sides of penetrations or transits and at any joints to provide adequate identification.

At all joints and terminations all cores, including multi-core spare cores shall be connected. Any unused core of multi-core cables shall be bonded at both ends to earth.

All compression joints for copper conductors shall comply with relevant standards.

6202011 Cable installation

Cables shall be run neatly on the surface by means of cleats or on cable ladder rack or tray, or laid in floor trenches or drawn into ducts or buried in the ground, as indicated by the CA.

Cable routes shall be agreed with the CA prior to commencement of work.

Cables shall be run at least 150mm clear of plumbing and mechanical services and below heating and hot water pipework.

Cables passing through structural floors or walls shall have galvanised sleeves, wrapped with a non-combustible tape and grouted in position.

Cables and cable containment systems installed in escape routes shall be in accordance with BS7671 Regulation 422.2.1, 422.2.2 and 422.2.3

Cables shall be installed in accordance with good installation practice.

Cables shall not be installed or removed from the drum unless the ambient temperature and the temperature of the cable are above 0°C and have been so for the previous 24 hours. Where cables have been subjected to temperatures below 0°C, care shall be taken to ensure that they are above that temperature before they are removed from the drum.

Take all necessary precautions to prevent damage to cables during installation.

Where cables are installed in situations where works by others are incomplete, take all reasonable precautions to protect the cables against damage arising from the execution of such other works.

In the event of damage to the sheath or armouring of a cable, the cable shall be replaced throughout its entire length.

All cables shall run directly from point to point without joints.

Where a cable changes direction, whether in a horizontal or a vertical plane, the radius of the bend in the cable shall not be less then the minimum laid down in BS 7671 and/or the relevant British Standard and shall comply with the manufacturers guidance, however the bending radius of cables during installation shall be kept as large as possible.

Three-phase groups of single-core cables carrying alternating current shall be laid, in trefoil formation and touching each other. Where this is not possible, the disposition to be adopted shall be agreed with the CA before installation is commenced.

All cables shall be pulled into position in such a manner as to avoid any damage whatsoever to the cable or its sheath. Cables shall wherever possible, be pulled directly from the top of the

drum, which shall be supported throughout the operation in such a manner that it is completely free to rotate.

Where circumstances make removal of the cable from the drum before pulling into position unavoidable, the cable shall be laid out neatly on a smooth clean area of ground completely free of debris or anything likely to cause damage to the cable. In such cases, 'figure-eights' shall be avoided wherever possible, and care shall be taken to avoid subjecting the cable to twisting.

An adequate number of cable rollers, each of which shall be undamaged and completely free to rotate, shall be used to support the cable during pulling, in such a manner that no part of the cable can touch the ground, the trench bottom or sides, or the walls of buildings. Cables shall not be dragged over concrete or other surfaces.

The number and positioning of rollers at bends in the route shall be such as to ensure that the minimum bending radius for the cable is not approached.

Cables shall, wherever possible, be pulled into position by hand, using an adequate number of operatives suitably positioned along the length of the cable.

Winches whether power driven or hand operated, and other mechanical aids shall only be used with the prior authorisation of the CA.

Wherever possible, cables which are intended to be winched into position shall be fitted by the manufacturer with a suitable pulling eye, firmly attached to all of the conductors, before being dispatched to site.

Whenever a winch or similar appliance is used, an approved tension gauge shall be fitted into the haulage line between the winch and the cable. The pulling tension must at all times be within the limit advised by the cable manufacturer, which shall be communicated in writing to the CA before the operation is commenced.

Cable stockings, when used, shall be of an approved pattern and the correct size, with swivel eye, in perfect condition, and shall be fitted with care to avoid damage to the cable sheath.

When a cable stocking has been used on a XLPE or LSF sheathed cable and the sheath, after removal of the stocking, shows signs of having been stretched, the cable shall be left for 30 minutes to recover. At the end of this period, if the sheath has not completely returned to its original position, the cable end shall be cut back by an amount equal to the length of the stocking plus 300mm, then immediately resealed.

During the course of pulling operations, the cable shall not be allowed, under any circumstances, to twist or rotate about its longitudinal axis because of excessive pulling tension or for any other reason.

Whenever the length and arrangement of a cable run is such that excessive tension would be likely to be needed to nose-pull the cable into position, the continuous bond method shall be employed. A wire pulling bond equal in length to twice the cable length, to which the cable shall be securely attached at intervals not greater than 1.8 metres. Snatch blocks shall be used at bends in the run to ensure that the pulling tension is taken by the bond and not by the cable.

Whenever a cable is cut, for whatever reason, the cut ends of both portions shall be immediately re-sealed. LSF and XLPE cables shall be sealed by means of an approved plastic cap embracing the armour wires and outer sheath.

All cable drums shall be handled with care to ensure that they are not damaged. All handling shall be carried out using sufficient and adequate plant and equipment.
All empty cable drums shall be stacked neatly in such a manner as not to obstruct access to, or about, the site or the operations of other trades.

Empty cable drums shall be removed promptly from the site and, in any case, not more than seven days after the cable has been removed from them. At no time shall more than three empty drums be stored on the site unless the CA has agreed otherwise.

Any cable joints shall be enclosed in a permanent joint chamber with removable cover in accordance with the requirements for draw-in pits.

Any work carried out requiring the use of split ducts shall be carried out in such a manner as to permit future cable withdrawal.

In rising ducts open to access, all non-armoured cables shall be protected against mechanical damage by the installation of a 300mm high mild steel 'kick-shield' suitably fixed at floor level. The 'kick-shield' to be of a suitable robust nature and treated against corrosion.

6202012 Inspection and testing

After installation and connection, all cables shall be inspected and tested for continuity and insulation resistance in accordance with the requirements of BS 7671. All results shall be recorded by the installer and approved by the CA.

6202013 Identification of cables

Except in the case where it is terminated in full view on to a clearly labeled switch, starter, distribution board or similar piece of apparatus, or on to a motor or other item of equipment the function of which is evident, each and every cable end shall be provided with an approved means of identification. In particular, this requirement shall apply to all cables terminating on the back, or in the base, of a cubicle type or similar switchboard or control panel and in any case where the function of the cable is not immediately obvious.

The means of identification shall be one or other of the following, or an approved alternative:

An engraved plastic label securely fixed to the cable sealing box (the cable sealing box must not be drilled or damaged however).

An engraved trafolyte label fixed to the cable with plastic cable ties.

A proprietary cable identification method with numbered/lettered ferrules on a label fixed to the cable.

Self-adhesive embossed plastic labels will not be accepted as permanent.

The cores of all control cables shall be individually identified at terminations, by means of approved plastic ferrules bearing indelible characters, in accordance with the numbering on the relevant wiring diagrams.

All cables run above ground shall be identified by means of engraved or stamped plastic label at intervals not exceeding 30 metres. The labels shall bear details of the cable size, number of cores, function, and reference number (if any) and shall be securely attached to the cables with cable ties

All cables run underground shall be identified at joint positions, in draw pits, and elsewhere at intervals not exceeding 30 metres. The labels shall bear details of the cable size, number of cores, function, and reference number (if any) and shall be securely attached to the cables with cable ties

All identification numbering shall be agreed with the CA before use and shall be clearly recorded on the 'as built' drawings and in the cable schedules.

6200000 ELECTRICAL SERVICES WORKMANSHIP AND STANDARDS

6203000 Low voltage modular wiring systems

6203001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Modular wiring systems shall meet the requirements of BS 7671, BS 8488 and BS EN 61535 both in their design, construction, function and installation.

Where the contractor proposes to use a modular wiring system, samples of all component types and cables shall be made available for the CA's inspection prior to procurement.

LV modular wiring systems shall be any system designed to operate at a nominal supply voltages of 230/400V.

Systems shall be fully designed, manufactured and tested in the suppliers factory so that the no re terminating of system cables or components is required on site.

Where components of the system are found to be incorrectly designed or manufactured, they shall be replaced by new fully constructed and tested items.

Where components or cables are damaged on site, they shall be replaced and not repaired.

Cables shall be properly sized before manufacture so that no cable within the system has more than 1 metre of spare length.

Cables emanating from the main distribution hubs to final accessories or luminaires shall be no more than 3 metres in length.

Cables installed in ceiling voids shall be supported in accordance with BS 7671. Cables laid on the back of ceilings or supported at each end shall not be accepted.

Where cables associated with modular wiring systems are installed in walls or partitions, they shall comply fully with BS 7671 Regulation 522.6.6 and 522.6.8

Where modular wiring systems are used to provided electrical services to escape corridors, their installation shall comply fully with BS 7671 Regulation 422.

Modular wiring systems shall be designed, manufactured and installed to allow for and to monitor harmonic content in the neutral conductors where that harmonic content can reasonably be expected.

All cables used in modular wiring systems shall be BASEC approved.

6203002 Referred documents

The works shall comply with the referred documents and standards. A full listing of referred documents is stated elsewhere in this specification. Where a standard comprises several parts all parts shall apply unless otherwise stated.

6204000 Testing and certification – general

6204001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The electrical installation shall be inspected and tested as required by BS 7671 and shall then be fully commissioned and left working.

Provide all labour (including specialist), special instruments, materials, fuel, lubricants, coolants, tools, plant and equipment required to carry out the pre-commissioning, commissioning and the performance testing of all elements.

The CA may request tests, at the installers or suppliers premises, of all or any of the materials and equipment used in the Contract Works in any manner he may deem necessary to ensure conformity with the specification. The results of such tests shall in no way relieve the Installer of his responsibilities to ensure that all materials and equipment installed in the works are entirely suitable for the applications and conditions of operations.

The testing of elements under the various sections of the specification may be required to be carried out in parts, or as a whole.

All tests shall be carried out to the complete satisfaction of the CA.

All instruments shall be calibrated immediately prior to commencement of the testing and shall be re-calibrated in accordance with the manufacturer's recommendation during the course of testing, as necessary. Copies of the calibration certificates shall be provided with the test results.

Test instruments used to measure the external impedance (Ze) of the installation shall be capable of reading as low as 0.001 ohms.

The installer shall demonstrate the installation or any portion thereof, which has been set to work, complies with the requirements of the specification.

Any defects of workmanship, materials, performance, maladjustment, non-compliance with the specification, or other irregularities which become apparent during the tests shall be rectified by the installer, at no additional cost to the contract and the tests repeated at the installers expense until the whole is proved free from defects and in complete working order. All systems shall be left sound and correct.

Publish a programme of the proposed inspections and testing works and detail requirements for the CA to witness such inspections and tests at least fourteen days prior to the beginning of such works.

The Installer shall provide to the CA, full settings, data and works of all equipment and systems at least fourteen days before beginning such works. The CA shall have the right to comment on such proposals.

6204002 Approval and acceptance

After receipt of the results of satisfactory tests, the CA shall authorise the Installer to proceed with the commissioning and system performance tests.

The Installer shall give the CA fourteen days written notice to his intention to demonstrate and seek 'approval' for any item or system.

The Installer shall allow for giving such notice and making adjustments, setting up and other preparations for testing and for witnessing such tests.

6204003 Protective device certification

All protective devices except fuses shall be tested to ensure operation within their design parameters and compliance certificates issued accordingly. This test may be carried out off site at the discretion of the CA for devices over 63A provided that each individual protective device can be clearly identified with its certified performance data.

6204004 Personnel

Carry out testing work using experienced electrical operatives who are fully trained in the use of the equipment and the requirements of the test. The CA may request evidence of competence for those carrying out testing.

Testing and commissioning of major items of proprietary plant shall be carried out by manufacturer's personnel. The Installer shall be responsible for arranging their programme of works to allow the CA to witness tests as required.

The CA shall ensure that all testing work carried out by such specialist manufacturers is carried out to his, and the CA's satisfaction and in such a way that it does not prevent him proceeding with the overall commissioning of the installation.

6204005 Inspection, test and electrical installation certificates

Inspection and test certificates shall be dated, numbered and clearly referenced to the item tested by means of serial, chassis or other manufacturer's reference number permanently marked in a conspicuous position on the item concerned.

The Installer shall issue an electrical installation certificate as required in BS 7671 at the practical completion of the works.

6204006 Works tests

The CA shall have the power to inspect at the makers' works, during manufacture and after completion, all or any manufactured material, apparatus or equipment ordered by the installer for incorporation in the Works and to require tests to be carried out in the presence of his representative in order to prove that the said material, apparatus or equipment meets the requirements of this Specification. All costs incurred in carrying out such tests and inspections shall be included in the contract and shall be borne in full by the installer.

The installer shall be responsible for ensuring that the CA is advised in writing whenever material, apparatus or equipment is ready for inspection and/or test at his own or his suppliers' premises. At least five days notice shall be given and due allowance shall be made for this period of notice in drawing up the programme of works.

The CA shall have the right to reject any material, apparatus or equipment which, as the result of inspections and/or tests may be found to be defective or unsatisfactory in any respect, or not in accordance with the requirements of the specification, and to require the installer to repair, adjust, modify or replace the defective items before dispatch to site. If the defective item be adjudged by the CA to be unsuitable for repair, adjustment or modification, then it shall be replaced by a completely new item at the expense of the installer.

No inspection or testing by the CA or his authorised representative nor the witnessing of satisfactory tests nor the authorising of dispatch to site shall in any way relieve the installer of any of his obligations under the contract, nor shall it in any way limit the right of the CA to reject such items after delivery to site if they subsequently prove to be defective or unsatisfactory or unsuitable for their intended purpose.

The installer shall be responsible for ensuring that all materials, apparatus and equipment required for the execution of the works are ordered sufficiently early to ensure delivery to site at the correct time as required by the construction programme. It shall be the responsibility of the installer to ensure that adequate time is available for inspection and/or testing by the CA, including the giving of required due notice. No materials, apparatus or equipment subject to inspection and/or test will be recognised as complete and ready for dispatch until after such inspections and tests have been satisfactorily carried out and no

claim for delay will be allowed unless the CA has failed to carry out inspection or to waive inspection after being given the specified period of notice.

6204007 Site tests

The CA shall have power to inspect all work in progress and upon completion or substantial completion and to require the installer to carry out tests in his presence or in the presence of his authorised representative in order to prove that all work carried out and all material, apparatus and equipment installed are wholly satisfactory and fully meet the requirements of this Specification. All costs and charges associated with or arising from such inspections and tests, including costs incurred by the installer in carrying out the prescribed tests and in attending upon the CA whilst tests and inspections are in progress shall be deemed to have been included in the contract price and shall be borne in full by the installer.

Upon completion of the electrical installation, or any substantial section thereof, the installation or that section and all of the associated electrical equipment shall be subjected to the tests specified in the relevant British Standards together with such other tests as may be required by the CA in order to prove compliance with this Specification. When no relevant British Standard exists, or the appropriate British Standard fails to specify tests, tests shall be carried out to the requirements of the CA.

The installer shall record all the details, measurements and data as required in the relevant standards. All test results shall be written at the time of test in blue ink and signed by the tester and any witness. Alterations or corrections shall be made by crossing out not by over-writing the previous data. No test results shall be corrected with correction fluids or similar correction media. Where the installer is unable to provide the original test certificates as described above, the tests shall be repeated at the installers cost.

The installer shall provide the original and a copy of the inspection and test sheets, together with any supportive documentation required by the relevant standards, to the CA within two days of the tests being carried out.

The inspection and test documentation shall indicate all of the test instrument details including the manufacturer, type, date of calibration, scale used and the recorded results/tolerances.

The result of each and every inspection and test carried out in accordance with the provisions of this Specification, whether or not witnessed by the CA shall be accurately recorded on an approved form of test certificate signed by the person in charge of the testing procedure. Test results shall be written at the time of test in blue ink and signed by the tester and any witness. Alterations or corrections shall be made by crossing out not by overwriting the previous data. No test results shall be corrected with correction fluids or similar correction media. Where the installer is unable to produce test results as described above the test shall be repeated at the installers cost.

An additional copy of every test certificate relating to site tests of the completed installation or parts thereof shall be included in the operation and maintenance manual.

The installer shall give at least fourteen days notice to the CA when the works or substantial sections thereof, will be completed and ready for inspection and test and before covering such works.

The CA shall have the right to reject any material, apparatus or equipment which, as the result of inspections and/or tests may be found to be defective or unsatisfactory in any respect, or not in accordance with the requirements of the Specification, and to require the installer to repair, adjust, modify, or replace the defective item. If the defective item be adjudged by the CA to be unsuitable for repair, adjustment or modification, then it shall be replaced by a completely new item at the expense of the installer.

No material, apparatus, equipment or installation shall be covered or otherwise permanently concealed from view until the CA has had the opportunity to inspect it and

either has formally waived his right to inspect it or has given written authorisation for covering to proceed following satisfactory tests and/or inspection.

6204008 Commissioning

Following the satisfactory conclusion of final inspections and tests on completed sections of the works, the installer shall duly commission each section of the electrical installation and leave it in full working order. For the purpose of this specification, the term 'commissioning' shall be deemed to include:

- The energising of electrical distribution circuits and equipment that have previously been inspected, tested, and found satisfactory and capable of being energised with complete safety.

- The setting of electrical protective devices and systems, where relevant, in accordance with the directions of the CA or, failing such directions, in accordance with sound engineering practice.
- The starting up of all electrically powered plant and equipment, including that supplied and installed under other contracts, as detailed in the annexed schedules.

- The verification of the performance of all such plant and equipment by the carrying out, where required, of further tests and the making of all necessary adjustments so as to obtain optimum performance.

Mere compliance with the requirements of this section of the Specification shall not by itself in any way relieve the installer of any of his obligations under the contract.

No approval given by the CA in connection with the commissioning process, whether by way of approval of procedures carried out or proposed, or approval of results obtained shall in any way relieve the installer of the contractual and statutory obligation to ensure that all connections and adjustments are made correctly and that the installations and equipment are handed over in a complete safe and satisfactory condition. Where required commissioning shall be carried out by the equipment manufacturer's commissioning engineers.

No connections or adjustments shall be made to plant or equipment that has already been commissioned and set to work, except with the prior consent of the CA.

All commissioning procedures shall be carried out in a safe and satisfactory manner and in accordance with the provisions of the Electricity at Work Regulations, the Health and Safety at Work Act, and the Electricity Safety, Quality and Continuity Regulations (where appropriate), to the complete satisfaction of the CA.

The CA shall have power to require that the whole of the plant, equipment and installations, or selected parts thereof, be re-inspected and, if necessary, re-test immediately before the end of the contractual maintenance period, and the installer shall be responsible for making all necessary arrangements with the Employer.

All commissioning documentation and certificates shall be included in the operation and maintenance documentation.

6240009 Periodic inspection and testing

Include recommendations within the operating and maintenance manuals that the installation be inspected and tested in accordance with BS 7671 and include a recommended maximum period before re test based on the advice given in BS 7671 guidance notes.

6310000 Generators

6310001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All equipment shall be supplied from a common manufacturer. Mixing of equipment where sustained operation and reliability have not been proven shall not be permitted.

6310002 Engine Type

Alternator driven by a prime mover which shall be a heavy duty, 4 stroke, compression ignition, water cooled, direct injection diesel engine running on class A2 fuel oil and be of adequate rating to drive the engineering auxiliaries and alternator continuously and without interruption.

6310003 Local Acceptance

The equipment shall be capable of accepting the full design load within 30-seconds of the start signal.

6310004 Cooling

Cooling of the equipment shall be via a fan assisted tropical rated radiator with pusher fan directly driven from the engine. The cooling system shall be a sealed system complete with all necessary headers and expansion tanks as required, and on completion of the installation the coolant shall have an appropriate amount of anti-freeze added.

6310005 Governor

Electronic engine speed governing to Class A1, providing optimum performance for the support of a frequency sensitive load shall be provided.

The equipment shall be capable of synchronising with the existing generator set.

6310006 Starting

Starting of the equipment shall be via by an axial type starter motor engaging on a toothed ring flywheel in conjunction with heavy duty 24 Vdc Lead Acid starting batteries.

The batteries shall be capable of providing a minimum of 6No 10 second long starts at -7ºC under normal conditions without recharging. The batteries shall be continually charged from a battery charger housed in the diesel alternator control panel whilst the engine is stationary.

An engine drive alternator and rectifier shall charge the battery when the engine is running and, in addition, a mains powered constant potential charger having normal and boost facilities.

6310007 Battery Charging

An engine driven charge alternator shall be provided complete with voltage regulator.

6310008 Lubrication

Lubrication shall be forced fed to the main and large end bearings, camshaft, valve rocker and timing gear. All other parts are by splash.

6310009 Filters

Simplex type filters shall be provided for:

- Fuel oil
- Lubricating oil
- Air intake

6310010 Alternator

The alternator shall comprise brushless design, screen protected to IP22, fan ventilated and fitted with a single long life, heavy duty bearing lubricant packed for life time running without attention. A PMG excitation system shall be included for support of non-linear and voltage sensitive load and optimum motor starting and short circuit performance.

6310011 Voltage Regulation

Voltage regulation shall be automatically maintained within the limits of +/- 1% from no load to full load at any power factor between 0.8 lagging and unity.

6310012 Insulation

The rotor and stator shall be insulated to Class H, with Class H (125 deg. C) temperature rise.

6310013 Coupling

Close coupling utilising a flexible coupling embodying flywheel and housing.

6310014 Base-frame

The assembled generating set shall be on a suitable base-frame with resilient anti vibration mountings.

6310015 Safety Guards

Safety guards shall be in compliance with relevant European and International standards.

6310016 Acoustic Enclosure

Where the generator is to be housed in a weatherproof acoustic enclosure, the enclosure shall be acoustically treated so as to ensure that the sound level when measured 1m from the enclosure is no greater than 65 dbA

The enclosure shall include the following:

1. Removable end for ease of installation/removal of generating equipment.
2. External, end mounted air inlet acoustic attenuation complete with fixed blade weather louvers and bird guard.
3. External, end mounted air extract acoustic attenuation complete with fixed blade weather louvers and bird guard.
4. Flexible air extract ductwork.
5. Walls and roof lined with 75mm mineral wool, retained by galvanised perforated steel sheet.
6. 2 hinged access doors both sides, complete with doors stays.
7. Internal AC & DC lighting.
8. Smoke/heat detector to automatically shut down the generator and fuel oil supply in the event of a fire within the generator enclosure.
9. Thermostatically operated heater(s).
10. Roof mounted, shot blasted, aluminium metal sprayed and silicone sealed medium gauge exhaust silencer (s).
11. Internal exhaust pipework lagged and clad with 50mm thick mineral wool.
12. Side cable entry access link box for power/control cable interconnections to LC board.
13. Finish painted in synthetic enamel to a RAL colour as specified by the client.

6310017 Fuel Oil

The generator shall be supplied complete with an integral day tank capable of running the generator non-stop for 8 hours. Any requirement beyond this shall be advised by the client. If biodiesel is to be used, the tank and all associated fuel lines, pumps etc shall be designed, manufactured and installed to prevent bacterial growth.

6310018 Generator Protection

Low oil pressure and high water temperature protection shall be provided by means of sensors mounted on the engine. The following conditions shall be indicated at the local control panel:

1. Low Oil Pressure
2. Low Water Level
3. High Water Level
4. Underspeed
5. Overspeed

The above fault indications shall be transmitted as a common alarm onto the BMS system or onto a standalone indicator panel located in a prominent position if no BMS is present. The engine shall also be fitted with gauges to indicate oil pressure and water temperatures.

A suitably rated 400V 50HZ 3 pole MCCB or ACB shall provide electrical protection. The breaker shall include over current and short circuit protection.

6310019 Synchroniser and Control Panel

The control panel(s) shall include the following features:

1. Automatic Engine Starting and Stopping
2. Automatic Shutdown on Fault Condition
3. Back-lit LCD Display
4. PC Configurable via MS-Windows based software
5. Engine Instrumentation Gauges
6. Generator Output Instrumentation
7. Alarm and Status Information
8. Push-button Controlled Operation
9. Remote Telemetry and Control via MS-Windows
10. Modem Communications
11. Configurable Digital Inputs
12. Configurable Relay Outputs
13. Configurable Timer Settings
14. Configurable Alarm Trip Points
15. Event Logging and Data Capture Facilities (minimum of 30No events)
16. Audible and LED Alarm Indication
17. Pre-Alarm facility on Monitored Values
18. Synchronisation control

The control panel(s) shall also include the following:

1. Engine heater control switch
2. Alternator heater control switch
3. On/Off Auto Selector switch
4. Mains failure simulator button
5. Return to normal supply button
6. Warm up timer
7. Engine run-on timer
8. Engine protection hold off timer
9. Multi-attempt to engage circuit
10. Three attempts to start detector and lock out control

11. Battery charge control switch

The metering displays shall be supplemented further by LCD display pages covering operating status and alarms.

LED indication shall be provided for:
1. Telemetry Active
2. Remote Start, System Lock
3. Safety on, Fault warning
4. Electrical trip
5. Fault shutdown
6. Fail to start
7. Low oil pressure
8. High engine temperature
9. Under/Over speed
10. Generator under /over volts
11. Emergency stop alarm

The module shall accept the following digital inputs: -

1. 9 fully configurable warning or shutdown inputs
2. 4 Analogue inputs re-configurable to read digital switches
3. Emergency Stop Input
4. Event logging recording the last 18 alarms/events

With the exception of the Emergency Stop Input, these shall be configurable to be either N/C or N/O contacts. The fully configurable auxiliary inputs provided to give protection expansion or control extra functions. These can be selected to be warning or shutdown inputs and should offer either immediate or “hold off” operation during start up.

Multiple alarm channels shall be provided to monitor the system including the following: -

1. Under/Over Generator Volts
2. Over-Current
3. Under/Over Generator Frequency
4. Charge Fail
5. Emergency Stop
6. Low Oil Pressure
7. Low Water Level
8. High engine temperature
9. High/Low Fuel with transfer pump control
10. Fail to start
11. Low/High DC Battery Volts
12. Fail to stop
13. Reverse Power
14. Earth Fault
15. Loss of speed sensing and programmable inputs as selected

6310020 Manual Control

Individual manual control facilities shall be provided at the synchroniser panel and also within any generator enclosure. The control at the synchroniser panel shall be via auto/manual key switches with synchroscope to allow manual synchronisation.

All breakers shall have auto/manual pushbuttons to allow manual operation.

6310021 Output Breakers

The new synchroniser panel shall include all facilities as necessary to accommodate the existing output connections.

All output breakers shall be provided with over current/short circuit protection and earth fault protection

Phase failure relays (existing/new) shall be provided such that automatic start up of the generators will commence upon loss of the supply.

Panel General Requirements

The panel shall be in accordance with the following:-

1. BS EN 61439
2. IEC 157/12
3. IEC 144
4. BS 7671

6310022 Enclosure

The enclosure shall be manufactured to BS EN 61439 and BEAMA Installations Form 4 to IP31 standard and purpose built, dead front type. The main construction comprising a welded hollow section steel frame with welded, hinged or bolted, 2mm zinc coated sheet steel panels. Sheet steel partitions shall be fitted between each section of the switchboard.

Access to the enclosure shall be provided for by means of suitable hinged doors fitted with lift off hinges.

The enclosure shall be designed and constructed so as to permit the connection of additional cables and/or wiring to outgoing circuits in complete safety without de-energising the whole switchboard.

The switchboard shall be suitable for top cable entry.

The enclosure shall be designed and constructed so as to provide effective segregation between incoming circuits/bus bars/outgoing circuits/control circuits and equipment. Where equipment is fitted above bus bar chambers it shall not be possible for objects to fall into the chamber. The segregation provided shall prevent the passage of ionised gas, resulting from the making or breaking of any circuit under normal or fault conditions, to any bus bar, adjacent switch etc.

6310023 Material and Finish

All steel nuts, bolts and washers shall be bright zinc plated.

Finish on sheet steel enclosures shall be rust proof and fungus resistant. All surfaces shall be degreased prior to painting then sprayed with one coat of etch primer, one coat of zinc chromate undercoat primer and two coats of high gloss top coat. Equipment exposed to the elements shall have a paint finish quality suitable to last without maintenance for 12 years. Paint finishes in internal equipment shall be of a suitable quality to last the life of the equipment.

6310024 Bus Bars

Bus bars shall be of high conductivity hard drawn copper having suitable phase colouring and mounted on stout insulated supports. The rating of the bus bars shall be at least the same current rating as that of the generators so connected.

All connections of the bus bars shall be made by mechanical clamps of the pinching bolt or shell type.

The internal connections shall be as short and direct as possible, of ample cross-sectional area, and be suitably insulated.

6310025 Earthing Connections

The switchboard shall have an earth bar to which all items of equipment shall be effectively bonded. This bar shall be of copper and shall be of the following minimum size: -

1. Equipment with 3 second rating - 40mm x 6.3mm.
2. Other equipment - 25mm x 3mm

The earth bar shall be bolted to the main frame and located so as to facilitate the connection of earth continuity conductors.

The metal sheaths and/or armouring of all cables connected to the switchboard or panel shall be bonded to the earth bar by means of a separate earth continuity conductor. This conductor shall comply with the requirements of BS 7671 subject to a minimum size of 4mm^2

Joints shall be tinned and bolted or clamped.

The frames of draw-out circuit breakers shall be earthed by means of a plug type contact sufficiently long to allow the shutters to close before contact is broken.

The star point of each group of CT secondary connections shall have a separate earthing link in an accessible position.

Each CT shall be provided with a shorting and earth link for safety purposes.

Neutral bus bars shall be insulated and, where necessary, shall have a cable gland and connection for an insulated single core earth continuity conductor.

All metallic cased equipment shall be earthed as follows: -

Every earthing connection shall be of copper or other corrosion resistant material and be securely installed and protected where necessary against damage and also where necessary against electrolytic corrosion.

Earth conductors shall be of stranded copper of the same size as the current carrying conductor but not less than 1.5mm^2 cross sectional area. Earthing cables where the current carrying conductor exceeds 4mm^2 shall be one half the cross sectional area of the current carrying conductor subject to a minimum of 4mm^2.

6310026 Internal Wiring and Terminations

Internal wiring shall be adequately supported. The supporting arrangement for cables and wiring being such that they are not liable to cause permanent physical damage or deformation to the conductor or insulation. Wiring shall not be bent to a radius less than the permissible value given by the manufacturers. In no case should sharp bends be made such as those formed by sharp edge pliers.

The internal wiring shall be carried out in a minimum of 1.5mm^2 cable for control circuits.

Cable ends shall be readily identified by means of indelibly marked ferrules.

All wiring shall be run in suitably rated trunking or supported by suitably rated cable ties.

The terminal blocks shall be so installed that the terminals are freely accessible and their terminal numbers easily read.

Where flexible cables are terminated on screw type terminals, insulated cable lugs shall be used.

Where auxiliary wiring terminal blocks accommodate wiring at different voltages these shall be segregated and clearly identified.

Flexible connections to instruments and hinged panels shall be supported to relieve the terminations of strain and shall be provided with a suitable shaped loop of a size adequate to accommodate the maximum movement required.

Wiring shall be protected by thermofit tubing

Wiring terminations of current transformers shall be by bolted connections.

All cores shall be identified at each end by means of numbers, letters or otherwise coded identification sleeves corresponding with the marking of the terminal strips to which they are connected and to the relevant schematic diagram.

6310027 Cable Glands and Terminations

All necessary cable connection facilities, spreader boxes etc., to suit the cable sizes shall be provided as part of the switchboard.

Auxiliary cables shall not be terminated in the same chamber as the main cables.

Glands and terminals shall be so designed and constructed as to minimise the bending of cable cores.

Cable cores shall be taken direct to the terminals of the associated equipment. Means shall be provided as part of the switchboard for securing these cores by means of clamps, trunking etc. Cores shall not be run with bus bars.

Terminations shall be made by sweated lugs, clamp connections of compression lugs. Unless indicated otherwise, glands for paper insulated cables shall be vertical, downward pointing, i.e. cable entry from below, using where necessary, reverse entry boxes or adaptors.

All external cabling connections shall be accessible from the rear of the switchboard.

There shall be adequate physical clearance at termination points for incoming and outgoing circuits cables to be made off and connected without sharp bends in the cables or their cores. All incoming cables shall be connected directly to the appropriate circuit breaker, fuse switch or starter by others.

6310028 Labels

All equipment shall be fitted with designation labels as follows: -

Selector switches would have an integral Perspex escutcheon plate with brushed aluminium backing and black inscriptions or to match the existing.

Pushbuttons, pilot lights and control switches shall have engraved black legend plates.

All other external equipment shall have mechanically fixed, engraved traffolyte designation labels, black letters on a white background. Internal equipment shall be identified by mechanically fixed, self-adhesive photo labels which shall have white letters on a black background or to match the existing.

6310029 Instruments

The instrumentation shall comprise an integrated digital display, with appropriate control functions.

The instrumentation shall meet standard the class 1.5 general instrumentation standard and shall be accurate to + 1%. The meters shall comply with BS 7194.

6310030 Current Transformers

Current transformers shall comply, where relevant, with BS EN 60044, be fitted to the fixed portion of the equipment, and be suited to the characteristics of the apparatus with which they are associated.

The CT's shall withstand safely and without damage the mechanical and thermal stresses set up by a short circuit equal to the full short circuit rating of the switchboard or panel, and also withstand safely and without damage for one minute the affects of an open circuit in the secondary circuit with full load in the primary.

The CT's shall be secured in position using a method which does not exert undue pressure on the winding.

Where CT's are called for, means shall be provided for properly securing these to the switchboard or panel proper. It will not be acceptable for CT's to be fitted and secured to cable cores.

All secondary connections shall be brought out to a terminal board by means of separate insulated leads. These leads shall be so arranged as to avoid the possibility of contact with any mains connection.

The CT's shall be clearly labeled or marked to show the polarity of primary and secondary windings and the duty or function of each transformer.

6310031 Locking Facilities

Locking facilities shall be provided to enable all shutters to be locked in closed position, to enable each fuse switch, switch-fuse, isolator etc. to be locked in the OFF position and to enable each changeover switch to be locked in all positions.

Padlocks shall be non-ferrous and not smaller than 25mm.

A minimum of 2 keys shall be provided with each lock or padlock.

Access doors to cubicle switchboards and panels shall have a lockable handle or padlock facilities.

Details of locks, keys, numbering etc., shall be confirmed with the CA before ordering.

6310032 Interlocking

Interlocks shall be provided to ensure that: -

The cover of any fuse switch, switchfuse isolator etc., cannot be opened with the switch closed.

Any fuse switch, switchfuse, isolator etc., cannot be operated with the cover opened.

Cubicle doors cannot be opened with the main isolator closed.

The main isolator for any cubicle cannot be operated with the door open.

6210033 Circuit Breakers

Circuit breakers over 800A rating shall be withdrawable type and fitted with a motor wound spring mechanism with the spring capable of being hand wound for emergency closing.

Circuit breakers rated at 800A or below shall be Moulded case type c/w over current and short circuit protection and of adequate fault rating.

6310034 Control/Monitoring

All connections, terminals and glanding facilities shall be provided to allow for control/monitoring cable connections to the various items of remote switchgear and control panels as further described in this specification.

Where interfacing with equipment not supplied under this Contract is required, the Contractor shall confirm with the appropriate Specialist Contractor (BMS Fire Alarm) the

operational requirements and shall ensure equipment compatibility, i.e. voltage and frequency etc. prior to manufacture and installation.

6310035 Load Bank Connection

The synchroniser panel shall allow for the connection of a suitably rated load bank. This shall comprise an ACB or MCCB with suitable cable entry facilities to allow connection of a remote load bank.

6310036 Panel Location/Mounting

The Contractor shall take all necessary site measurements so as to ensure satisfactory alignment of the panel and provision for the making off of cable connections.

6310037 Remote Monitoring

Where required, the contractor shall allow for remote monitoring either by BMS or to a central monitoring station of the clients choice.

Voltage free contacts or transducers shall be provided as appropriate, together with wiring terminating at labelled DIN rail mounted terminals.

The terminals for the above shall be housed in separate compartments within the control/synchroniser panel, with glanding facilities for the remote cabling. Outgoing wiring to a BMS remote station will be provided and installed by others if required.

6310038 Load Sharing

Where multiple generating sets are provided, they shall be capable and configured for load sharing.

6310039 Restoration of Mains Supply

An auto/manual key switch shall be provided.

When selected in auto, upon restoration of the mains and after a 0-15 min adjustable timer has expired the Generator circuit breaker shall open, the mains circuit breaker shall close and any non-essential load or shed load shall be reconnected. After a predetermined cooling period, the generator sets shall shut down. When selected in the manual mode, the system shall continue operating on generator supply until the changeover is initiated manually. Manual restoration shall initiate the same changeover/shutdown sequence as per the description for auto.

6310040 Overcurrent and Short Circuit Fault Protection

Overcurrent and short circuit fault protection shall be provided to the generator breakers to protect both when operating via the synchroniser panel.

6310041 Testing And Commissioning

General
The whole of the fuel pipework installation shall be tested with nitrogen to twice the working pressure of the system or 4 bar (60 psig), whichever is the greater. This pressure shall be maintained for a period of two hours in each case, and allowance shall be made for attendance by the Supervising Engineer during the progress of such tests.

Any equipment fitted not suitable for this test pressure shall be adequately protected or isolated from the system during the test.

Diesel Alternator
On completion of manufacture of the diesel alternator sets and synchroniser panel and before dispatch from the works, the Contractor shall arrange for the set to be tested. The Contractor shall include in his tender for all costs involved in arranging for these tests to

be witnessed by the Client or his representatives. A minimum of seven days' notice shall be given for such tests.

The Contractor shall include for commissioning the new set(s) on site to the satisfaction of the Engineer and shall provide for all flushing oil, lubricating oil, coolant liquid, anti-freeze and fuel oil.

After commissioning the Contractor shall fully test all controls, switching and protection, and shall provide completed test certificates as appropriate.

In addition, a 4 hour full load and efficiency test shall be carried out and test sheets completed.

The Contractor shall allow for providing inductive (0.8pf) load banks suitable for testing as follows:-

4 hour test on the new generator sets on full load and in steps of 50% and 25% full load.

Final system test at full load and in steps of 100%, 50% and 25%.

The Contractor shall also allow for commissioning and testing of any external monitoring proving the communications link.

6321000 Switchboards

6321001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The switch board assembly shall be suitable for connection to the supply system as stated in the design criteria.

6321002 Rated voltage

The rated voltage of all switchgear and distribution boards shall be not less than 500 volts ac between phases.

6321003 Switch board assembly

The assembly shall be designed and constructed to withstand the thermal and mechanical stresses set up by short-circuit conditions from a source fault level as stated elsewhere.

The numbers, sizes and ratings of units incorporated within the switch board shall be as indicated on the drawings and schedules.

The assembly shall be a CE marked, ASTA certified, multi-cubicle, type-tested assembly (TTA) to BS EN 61439-1 with Form 4 segregation in accordance with BEAMA Installation recommendations. The type of Form 4 segregation is stated elsewhere. A copy of the specific certification shall be provided to the CA and included in the operational and maintenance manuals.

The assembly shall be manufactured from high grade, machine folded/welded, zinc coated, sheet steel of not less than 2mm thickness and be provided with a 50mm high (minimum), removable rolled mild steel plinth.

The assembly shall have characteristics appropriate to the conditions upon which the design is based. Equipment shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

The assembly shall be capable of supporting the weight of a person walking on the enclosure without damage.

Doors shall be provided with neoprene gaskets and door mounted equipment shall be restricted to instruments, control switches and switch operating handles. Door handles shall have an integral cylinder lock and two keys shall be provided for each lock. Keys shall be fully labelled and handed to the CA at practical completion.

Each section of the assembly shall be divided into compartments on a modular basis, to ensure that future alteration and/or additions of equipment can be accomplished without difficulty (i.e. bolted removable divisions, not welded).

The assembly shall be readily extendible at either end, with pre-drilled busbars and removable busbar chamber end panels. The layout shall be selected to provide the shortest practicable switch board length.

Removable un-drilled gland plates not less than 3 mm thick shall be provided. Gland plates for single core cables shall be non-magnetic.

Connections from the busbars to the live side of functional units shall be shrouded to IP 2X minimum, with warning labels.

Outgoing circuits shall be arranged and separated such that connections can be made and maintenance carried out on any piece of equipment, without disturbance to another.

Removal of any covers for cabling outgoing circuits shall not expose any live parts. An integral secondary barrier shall be provided.

Full segregation shall be maintained between circuits operating at different voltages. All terminals shall have clear covers marked with the operating voltage.

Suitable windows shall be provided at key locations for thermo graphic testing of bus bars. Each window shall be provided with a bolted metal cover.

Heavy duty, galvanised cable tray shall be provided to support cables at the rear of the enclosure.

The assembly shall include air circuit breakers, moulded case circuit breakers, fuse-switch-disconnectors, switch-fuse-disconnectors or disconnectors, as specified elsewhere. Unless otherwise stated, feeders shall be triple-pole with removable bolted link neutral. Cable boxes shall be manufactured to accept the incoming cable arrangement stated elsewhere.

Where a source of generation is to be installed and connected to the installation, the source shall be provided with overcurrent protection on the a.c. side.

Generation systems shall only be connected into the system on the live side of the main switchboard.

Generation systems shall comply with the requirements of BS 7671 and shall constitute any of the following:

- CHP
- CCHP
- Solar voltaic
- Standby generation
- Wind turbines
- Water turbines

All feeder equipment shall be ASTA certified, independent operated, capable of being locked in the OFF position and suitable for uninterrupted duty in the closed position at rated loads.

The contractor shall undertake a full protection study based on the selected equipment to include HV/LV discrimination and all downstream LV discrimination. The study shall be verified and adjustments made if necessary at least 1 week before practical completion.

Each switch board shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

The schedule shall be typed on an A4 sheet, framed and securely fixed to the switch board and adjacent wall as appropriate.

6321004 Busbars

The assembly busbar and dropper/riser system shall be housed in a separate earthed metal chamber, with the main busbar located at the top of the switchboard. Busbars and droppers shall be ASTA certified for the fault rating and continuous rating stated.

As a minimum, the neutral busbar shall have the same rating as the phase busbars. However, subject to confirmation from the CA the busbar may be uprated to cater for the potential presence of harmonic currents.

Where specified, the busbar system shall be arranged for the neutral earthing of the supply transformer to be made within the switchboard. Removable links shall be provided for testing purposes.

Busbars shall be manufactured from hard drawn, high conductivity copper.

Busbars shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin as noted above.

Where specified, busbars shall be insulated throughout their length by PVC tape or sleeving with industry standard colours. Tape shall comply with BS EN 60454-3 and sleeving with BS EN 60684.

All busbar joint surfaces shall be tinned or plated and all joints shall be bolted with vibration resistant fixings.

Busbar supports shall be non-hygroscopic, anti-track, and flame retardant. Busbar supports shall be strong enough to withstand, without damage, the forces set up by any thermal expansion and forces created by fault currents.

Means shall be provided to prevent arcs or arc products occurring on one busbar from affecting the other busbars.

Access to busbars and connections shall only be possible by the use of tool and covers shall be fitted with engraved laminated labels with the legend 'BUSBARS' in 10mm (min) black lettering.

6321005 Earthing

A suitably rated copper earth bar in accordance with BS EN 61439-1 shall be provided throughout the length of the switchboard. It shall be pre-drilled to each end for future extension and removable end plates shall be provided.

The earth bar shall be drilled to accommodate all protective conductors and the incoming supply cable earth as well as an external earth bar.

All protective conductors shall be connected to the earth bar by brass nuts and bolts, with flat and spring washers. All connections shall be labelled at their termination point at the earth bar.

A main earth termination point shall be provided inside each incomer compartment.

All equipment and metalwork, including gland plates, shall be connected to the switchboard earth bar. All hinged doors and removable covers shall be bonded by separate flexible earth conductors.

An earth connection shall be made to each gland and/or armour clamp where cables terminate at the assembly.

The earth bar shall be manufactured from HDC Copper.

6321006 Identification of switch boards

Identification and warning labels shall be in accordance with BS 5499:Part 1.

Switch boards shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws. Lettering shall be black on white labels and the wording shall be agreed with the CA.

The main control switch or circuit-breaker shall be labelled, 'DISCONNECTOR' and numbered 1, 2, etc., if there are two or more incoming supplies. The characters shall be at least 10mm high and 1.5mm thick.

On all other labels the characters shall be at least 4mm high and 0.5mm thick.

A warning label shall be fixed to the front of the switch board

6321007 Labels and diagrams

All switchgear/ fusegear/ disconnectors and distribution units, etc., shall be clearly marked with engraved laminated plastic labels, secured by screws to the cases, clearly indicating the service, voltage and phase of the circuit or apparatus controlled.

A diagram showing the details, rating and function of each switch, size and number of cores of all outgoing cables, location, size and rating of all distribution boards fed from that switchboard and the phase of each outgoing circuit shall be provided at each switchboard.

These diagrams shall be mounted in glazed frames or similar of an approved design and the layout and mounting shall be approved by the CA prior to installation.

6322000 Panel boards

6322001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The panel board assembly shall be suitable for connection to the supply system as stated in the design criteria.

Panel boards for the purposes of this specification are defined as wall mounted MCCB or fuse boards intended to provide re-distribution and circuit protection of distribution cables between switchboards and distribution boards.

In smaller installations, panel boards may be used as switchboards if stated on drawings or in particular elements of this specification.

6322002 Rated voltage

The rated voltage of all switchgear and distribution boards shall be not less than 500 volts ac between phases.

6322003 Panel board assembly

The assembly shall be designed and constructed to withstand the thermal and mechanical stresses set up by short-circuit conditions from a source fault level as stated elsewhere.

The numbers, sizes and ratings of units incorporated within the panel board shall be as indicated on the drawings and schedules.

The assembly shall be a CE marked, ASTA certified, multi-cubicle, type-tested assembly (TTA) to BS EN 61439-1 with Form 4 segregation in accordance with BEAMA Installation recommendations. The type of Form 4 segregation is stated elsewhere. A copy of the specific certification shall be provided to the CA and included in the operational and maintenance manuals.

The assembly shall be manufactured from high grade, machine folded/welded, zinc coated, sheet steel of not less than 1.5mm thickness.

The assembly shall have characteristics appropriate to the conditions upon which the design is based. Equipment shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

Doors shall be provided with neoprene gaskets. Door handles shall have an integral cylinder lock and two keys shall be provided for each lock. Keys shall be fully labelled and handed to the CA at practical completion.

Removable un-drilled gland plates not less than 2 mm thick shall be provided. Gland plates for single core cables shall be non-magnetic.

Connections from the busbars to the live side of functional units shall be shrouded to IP 2X minimum, with warning labels.

Outgoing circuits shall be arranged and separated such that connections can be made and maintenance carried out on any piece of equipment, without disturbance to another.

Removal of any covers for cabling outgoing circuits shall not expose any live parts.

Full segregation shall be maintained between circuits operating at different voltages. All terminals shall have clear covers marked with the operating voltage.

The assembly shall include moulded case circuit breakers, fuse-switch-disconnectors, switch-fuse-disconnectors or disconnectors, as specified elsewhere. Unless otherwise stated, feeders shall be triple-pole and neutral. Cable boxes shall be manufactured to accept the incoming cable arrangement stated elsewhere.

Where a source of generation is to be installed and connected to the installation, the source shall be provided with overcurrent protection on the a.c. side.

Generation systems shall only be connected into the system on the live side of the main switchboard and not panel boards.

All feeder equipment shall be ASTA certified, independently operated, capable of being locked in the OFF position and suitable for uninterrupted duty in the closed position at rated loads.

The contractor shall undertake a full protection study based on the selected equipment to include HV/LV discrimination and all downstream LV discrimination. The study shall be verified and adjustments made if necessary at least 1 week before practical completion.

Each panel board or panel shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

The schedule shall be typed on an A4 sheet, framed and securely fixed to the panel board or wall as appropriate.

632204 Busbars

As a minimum, the neutral busbar shall have the same rating as the phase busbars. However, subject to confirmation from the CA the busbar may be uprated to cater for the potential presence of harmonic currents.

Busbars shall be manufactured from hard drawn, high conductivity copper.

Busbars shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin as noted above.

Busbar supports shall be non-hygroscopic, anti-track, and flame retardant. Busbar supports shall be strong enough to withstand, without damage, the forces set up by any thermal expansion and forces created by fault currents.

Means shall be provided to prevent arcs or arc products occurring on one busbar from affecting the other busbars.

Access to busbars and connections shall only be possible by the use of tools.

6322005 Earthing

The earth bar shall be drilled to accommodate all protective conductors and the incoming supply cable earth as well as a connection to an external earth bar.

All protective conductors shall be connected to the earth bar by brass nuts and bolts, with flat and spring washers. All connections shall be labelled at their termination point at the earth bar.

A main earth termination point shall be provided inside each compartment.

All equipment and metalwork, including gland plates, shall be connected to the panel board earth bar. All hinged doors and removable covers shall be bonded by separate flexible earth conductors.

An earth connection shall be made to each gland and/or armour clamp where cables terminate at the assembly.

The earth bar shall be manufactured from HDC Copper.

6322006 Identification of switch panels

Identification and warning labels shall be in accordance with BS 5499:Part 1.

Switch panels shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws. Lettering shall be black on white labels and the wording shall be agreed with the CA.

The main control switch or circuit-breaker shall be labelled, 'DISCONNECTOR' and numbered 1, 2, etc., if there are two or more incoming supplies. The characters shall be at least 10mm high and 1.5mm thick.

On all other labels the characters shall be at least 4mm high and 0.5mm thick.

A warning label shall be fixed to the front of the switch panel.

6322007 Labels and diagrams

All switchgear/ fusegear/ disconnectors and distribution units, etc., shall be clearly marked with engraved laminated plastic labels, secured by screws to the cases, clearly indicating the service, voltage and phase of the circuit or apparatus controlled.

A diagram showing the details, rating and function of each switch, size and number of cores of all outgoing cables, location, size and rating of all distribution boards fed from that panel board and the phase of each outgoing circuit shall be provided at each panel board.

These diagrams shall be mounted in glazed frames or similar of an approved design and the layout and mounting shall be approved by the CA prior to installation.

6323000 Distribution boards

6323001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All distribution boards shall be type-tested and comply with BS EN 61439-1 and BS EN 60439-3. They shall be suitable for surface mounting, have lockable doors (supplied with two keys) and be controlled by an on-load integral disconnector. Keys shall be labelled and handed to the CA at practical completion.

All distribution boards shall be fitted with miniature circuit breakers as specified elsewhere. Where spare ways are provided they shall be fitted with blanking pieces.

All neutral and earth connections shall be made to bars within the distribution board, each connection having an individual terminal. The neutral shall have a removable link to facilitate testing.

The earth bar shall have the capacity to connect to an external earth bar.

Where specified elsewhere a separate isolated secondary earth bar shall be provided within the enclosure. This earth bar shall be of similar size to the protective earth bar but shall be insulated from the remainder of the assembly.

The connections to the neutral and earth bars shall be made to correspond with the order of the phase connections.

All conductors terminating at distribution boards shall be appropriately marked with cable ring markers indicating the circuit number and where appropriate phase connection.

All covers, doors and access plates into the distribution boards shall be gasketed to achieve a minimum protection as follows: -

- Internally IP32
- Externally IP65

Access for cabling shall be from the front only. Shrouding to IP2X shall be fitted to prevent accidental contact with live parts. Warning labels shall be provided.

Each distribution board shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

The schedule shall be typed on an A4 sheet, laminated and securely fixed to the inside face of the distribution board door.

An engraved designation label shall be fitted to the front of the board.

6323002 Identification of distribution boards

Identification and warning labels shall be in accordance with BS 5499:Part 1.

Distribution boards shall be permanently identified. Labels shall be of a laminated plastic material attached to the apparatus by screws. Lettering shall be black on white labels and the wording shall be agreed with the CA. The characters shall be at least 10mm high and 1.5mm thick.

On all other labels the characters shall be at least 4mm high and 0.5mm thick.

A warning label shall be fixed to the front of the switch board

6324000 Consumer units

6324001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Consumer units shall only be used in domestic installations.

All consumer units shall comply with BS EN 61439 and BS EN 60439 They shall be suitable for surface or flush mounting and be supplied in either insulated or metal enclosures as indicated on the drawings or in particular information.

All consumer units shall be fitted with miniature circuit breakers as specified elsewhere. Where spare ways are provided they shall be fitted with blanking pieces.

All neutral and earth connections shall be made to bars within the consumer unit, each connection having an individual terminal. The neutral shall have a removable link to facilitate testing.

The connections to the neutral and earth bars shall be made to correspond with the order of the phase connections.

All conductors terminating at distribution boards shall be appropriately marked with cable ring markers indicating the circuit number and where appropriate phase connection.

Consumer units shall be supplied without any openings in their enclosure. Semi punched circular knock outs are acceptable in metal consumer unit enclosures provided all are intact unless removed to allow cable entry. All knock outs shall be fitted with grommets where cables pass through.

Insulated consumer units shall be provided with the facility to remove pre formed cut outs designed to accommodate cable entry. These shall only be removed to accommodate cables.

Any consumer unit enclosure which has knock outs or cut outs removed and not used for cable transit shall be replaced.

Consumer units shall have a main terminal rating of 25mm^2 CSA.

Main switch disconnectors shall be a minimum 100A rated.

Split load consumer units shall incorporate a 63A or 80A 30mA RCD for earth fault protection unless indicated differently in particular information.

Overload and short circuit protection shall be via individual MCB’s on each of the outgoing circuits.

Access for cabling shall be from the front only. Shrouding to IP2X shall be fitted to prevent accidental contact with live parts. Warning labels shall be provided.

Each consumer unit shall be provided with a circuit schedule identifying each individual circuit giving reference, description, rating of protective device and connected load.

Each consumer unit shall be fitted with a label giving emergency contact details for the installing company.

6325000 Enclosures

6325001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Enclosures shall mean any protective cabinet or cover installed to prevent access to live parts or equipment as specific to a project.

Unless stated otherwise the enclosure protection shall be at least:

- Internally IP32
- Externally IP65

Ferrous parts of indoor enclosures shall be adequately rust protected and shall be finished with an electrostatically applied, powder coated finish.

Outdoor enclosures shall be provided with a hot-dip galvanised coating complying with BS EN ISO 1460 or a sheradized coating complying with BS 4921. A decorative finish is not necessarily required unless identified in particular requirements.

Provision shall be made for locking or padlocking of enclosure covers as necessary.

Fixing holes in indoor type enclosures of apparatus may be inside or outside the enclosure. Outdoor type enclosures shall have external fixing lugs.

6326000 Switched fuses and fused switches

6326001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Switched fuses and fused switches shall be rated for fault make, load break, BS EN 60947-3 utilisation category AC22 for distribution feeders and AC23 for motor feeders.

Switched fuses and fused switches shall be fitted with suitably rated BS 88 HRC fuse links.

Disconnectors, switched fuses and fused switches shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

Each feeder device shall be in a separate compartment with a hinged door interlocked with the disconnector, so that the door cannot be opened when the device is closed or locked open.

Positive drive ON/OFF indicators shall be provided.

The following mechanical interlocks shall be provided on all compartments or enclosures equipped with a disconnector: -

It shall not be possible to open the door with the disconnector in the ‘ON’ position.

It shall not be possible to open the door with the disconnector padlocked ‘OFF’.

The door may be opened only when the disconnector is fully opened and the operating handle is in the ‘OFF’ position.

When the door is open, clear, unambiguous indication of the disconnector position shall be given on the fixed parts of the device.

The ON/OFF positions of operating handles shall be identical for all types of disconnector on the assembly

All exposed live terminals shall be shrouded to IP2X and provided with warning notices. Opening the device shall not expose any live parts. An integral secondary barrier shall be provided.
Spare space on assembly tiers shall be arranged to allow the simple addition of a feeder device in the future.

In the event that part of an assembly tier is empty, spare 100A fuse-switch-disconnectors shall be fitted to fill the spare space.

All disconnectors, switched fuses and fused switches shall be clearly labelled.

Where individual items of switchgear are to be grouped together, or where it is reasonable to do so, they shall be formed into a composite switchgear panel. Floor mounted units are preferred.

All apparatus (including associated equipment and accessories) shall be fixed independently of the system or wiring. All fixing screws or bolts shall be of steel. Where the apparatus has a protective coating of zinc, or is mounted outside a building, the bolts or screws shall be zinc plated (electro-galvanised) complying with BS EN ISO 2081.

6326002 Ironwork for switch frames

Framework for the mounting of loose switchgear, distribution boards and similar equipment shall be of mild steel plate, section and bar or hot rolled hollow sections complying with BS EN 10210-2, or slotted angles complying with BS 4345.

Black hexagon bolts, screws and nuts complying with BS 3643 may be used.

Framework mounted within a building shall be wired-brushed or shot-blasted, cleaned and given a brushed coat of zinc chromate primer and two coats of finish to match the switchgear. Manufacturers' standard finishes will be accepted for slotted angles, but all metal exposed by cutting shall be prepared and finished to match the paint finish applied by the manufacturer.

Framework mounted outside a building shall be of galvanised mild steel plate, section and bar or hollow section, or galvanised slotted angles complying with BS 4345. Bolts, nuts and screws shall be galvanised or zinc plated (electro-galvanised). Untreated areas of metal, e.g. cut ends, holes and areas damaged by welding, shall be given a coat of zinc rich paint.

6326003 Identification of switched fuses and fused switches

Identification and warning labels shall be in accordance with BS 5499 Part 1.

Switched fuses and fused switches shall be permanently identified. Labels shall be at least 4mm high and 0.5mm thick.

6327000 Circuit breakers and RCD's

6327001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

6327002 Air circuit breakers (ACB)

ACB's shall be ASTA certified and in accordance with BS EN 60947-2. ACB's shall be horizontal, draw-out type, with stored-energy, independent, quick make and break, trip-free operation, with anti-pump. ACB operating mechanisms shall be manual or motor loaded with manual loading facilities, spring stored energy type, as specified in the particular requirements of this specification. Trip circuits shall operate at voltages recommended by the manufacturer.

ACB's shall be full load rated for continuous use under normal operating conditions. They shall be capable of operating at their maximum setting 24 hours a day continuously.

ACB's shall be either triple-pole and neutral or four-pole, as specified elsewhere in this specification or on drawings.

ACB's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

ACB's shall have service, test and isolated positions and be capable of being locked in the OFF position. In the isolated position, all circuits shall be isolated. In the test position, only the control circuit shall be made.

Automatic, lockable safety shutters shall be provided to prevent access to live terminals in the disconnected or test positions. Interphase barriers shall be provided to prevent arc propagation. Interlocks shall be provided to ensure that the circuit breaker is open during connection and disconnection.

A test block shall be provided at the unit front to allow secondary injection testing of all relays and tripping circuits without the disconnection of any wiring.

ACB's shall be complete with auxiliary contacts and terminals for the required controls and indications, together with all appropriate transformers and fuses.

Air Circuit breakers shall have mechanically operated 'ON/OFF' and 'CHARGE/DISCHARGED' indication.

ACB's of the same rating shall be interchangeable. ACB's of a different rating, but of the same frame size shall not be interchangeable.

Where alternate or dual supplies are present, ACB's shall incorporate Castell interlocks as necessary. This shall also include any ACB's used as a means of coupling busbars.

Protective relays shall be provided for each incoming ACB. Overcurrent protection shall be inverse definite minimum time (IDMT) relays. Restricted earth fault protection shall be by high-stability circulating current relays and Class X current transformers, of suitable characteristics. The installer shall allow for the full setting up and testing to the satisfaction of the CA of all protective relays

Where the associated power transformer is cast resin or silicone insulated type the ACB shall trip on high winding temperature.

Each ACB shall be provided with an operating handle for racking the ACB in and out for isolation, etc.

All ACB's shall be clearly labeled.

6327003 Moulded case circuit-breakers (MCCB)

All MCCB's shall be to BS EN 60947-2 and of the current limiting type.

MCCB's shall be of the quick-make and break, independent, trip-free type with mechanical ON/OFF/TRIPPED indication

MCCB's shall be full load rated for continuous use under normal operating conditions. They shall be capable of operating at their maximum setting 24 hours a day continuously.

For switchboard mounting MCCB's shall be the cubicle mounting type with door mounted padlocked rotary type operating handle. They shall be of the fixed pattern with fully shrouded fixed contacts. Interlocks shall be provided to prevent the opening of the front cover with the operating handle in the 'ON' position.

MCCB's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

The operating mechanism shall operate all poles simultaneously during opening, closing and tripping operations.

Each pole of the MCCB shall be provided with thermal element for inverse time delay protection and magnetic element for short-circuit protection. The thermal release shall be adjustable and fitted with a lock-off facility.

Ensure that demonstrable discrimination is achieved between the up and down stream devices. Selection of MCCB's on the cascade principle will not be accepted.

MCCB's shall be of a type suitable for the fitting of motorised operators or shut trip devices.

All MCCB's shall be clearly labeled.

6327004 Miniature circuit breakers (MCB)

Minature circuit-breakers (MCB) shall comply with BS EN 60898-1, and have a minimum rated short circuit capacity (Icn) of 10kA unless otherwise specified.

MCB's shall be full load rated for continuous use under normal operating conditions. They shall be capable of operating at their maximum setting 24 hours a day continuously.

MCB's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

Three-phase MCB's shall trip all phases on any fault condition.

Provision shall be made to enable the operating mechanism to be padlocked in the 'OFF' position.

6327005 Residual current devices and residual current breakers with overload protection (RCD and RCBO)

Residual current devices (RCD) shall comply with BS EN 61008 (RCD) or BS EN 61009 (RCBO).

RCD's and RCBO's shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

The units shall be double or triple-pole as required and mounted enclosed within the distribution board panels or purpose made enclosure.

RCD's (ie: devices with no overload or short circuit protection) shall only be used where appropriate overload and short circuit protection is provided by other means and then only with the agreement of the CA. The contractor shall not rely on overload or short circuit protection provided by others to justify the use of RCD's

The RCD/RCBO shall automatically open the protected circuit on an earth leakage fault between phase and earth equal to or greater than the fault current sensitivity rating of the device.

The sensitivity ratings of the RCD/RCBO shall be as indicated on the schematic diagrams and where specified shall be adjustable between the ranges stated. As a minimum the rating for RCD or RCBO's protecting final circuits shall be no more than 30mA, shall operate in less than 40mS and pass a current of no more than 5 times the circuit protection rating.

The operating mechanism shall be independent trip-free and shall not be able to be held closed against an earth fault. The units shall be complete with a test button and trip re-set device.

Devices that require testing more than once per year to remain operational shall not be used.

The RCD/RCBO shall have positive contact indication whereby the opening of the device is clearly indicated by a mechanical indicator. This indicator shall be linked to the device main contacts to show the positive opening of all poles.

6328000 Fuses

6328001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Cartridge fuse-links shall comply with BS EN 60269-1 (BS 88). Cartridge fuse-links shall have a Utilisation Category of gG for general applications, including motor circuits. Category gM fuses shall only be used on motor circuits. Category ‘a’ breaking range fuses shall not be used.

Where fuses are used in electrical distribution systems, 2 spare fuses of each size and configuration installed shall be handed to the CA on project completion.

6329000 Contactors

6329001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Contactors shall comply with BS EN 60947-4 and be rated AC3.

Contactors shall be of the multi-pole double-break, fully shrouded, block pattern, with replaceable main and auxiliary contacts. Operation shall be from a separate source. Each contactor shall incorporate auxiliary contacts and the control circuit shall operate at a voltage not exceeding the phase/neutral voltage. Where more than five triple-pole contactors are used, a separate control transformer shall be provided.

Contactors shall be capable of withstanding calculated operational and fault currents as well as calculated power frequency stress voltages and voltages of atmospheric origin, the latter subject to the decision to install surge protection.

Where contactor noise is required to be minimal d.c. operated contactor coils shall be used.

Where contactors are independently mounted, they shall be totally enclosed in a metal case with hinged and/or bolted on covers. Contactors mounted within a cubicle shall be housed within a separate compartment.

All contactor control wiring passing through any adjacent switchgear shall be contained within an internally mounted metal duct/conduit.

6330000 Protection against voltage disturbances

6330001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Appropriate surge protection shall be fitted to protect against the effects of voltage disturbances both from internal and external sources. Where surge protection is not installed, the installation and all connected equipment (including portable appliances) shall comply with the requirements of table 44.3 in BS 7671.

Surge protection devices shall comply with BS EN 61643. Where installed for protection against lightning strike, they shall in addition comply with BS EN 62305-4.

6330002 Voltage disturbances from an external source

Transient over-voltages can be imported into a building through the cables entering it. Transient overvoltage surge protection shall therefore be installed on all cables either entering the building such as power supply cables, telephone and data cables. In addition, transient overvoltage surge protection shall be installed to protect cables leaving the building and supplying power or data connections to satellite installations or electronic equipment mounted outside of the building.

6330003 Voltage disturbances from an internal source

Where required, internal transient overvoltage surge protection shall be installed as indicated on drawings and in particular requirements.

Transient over-voltages can be generated within a building from a number of sources including large inductive loads, inductance and capacitance of long cable runs or lightning strikes directly on the building. Appropriate surge protection shall therefore be installed at switch boards, panel boards or distribution boards throughout the installation as indicated on drawings and in particular information.

6331000 Metering

6331001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

6331002 Utility meters

Provision shall be made to accommodate the requirements of the energy suppliers meters.

6331003 Meter tails

Meter tails shall comply with BS 7211, be no longer than 1 metre (unless specifically agreed with the Distribution Network Operator (DNO)) and be XLPE insulated LSF sheathed of the size and rating noted in the schedules or on the drawings.

6331004 Main switch board or panel board

The main switchboard or panel board shall be equipped with a multifunction digital panel meter displaying the following:

1. Instantaneous single and three phase voltage
2. Peak single and three phase voltage
3. Instantaneous phase current (all phases)
4. Maximum demand phase current (all phases)
5. Power factor
6. Cumulative energy use in kWh
7. Real time energy use in kVA
8. Real time energy use in kW
9. Real time reactive power use in kVAr,
10. Total harmonic distortion expressed as a percentage (THD)
11. Time and date

All the functions, which the meter is capable of displaying, shall be continuously transmitted via either an RS 485 interface or via TCP/IP LAN connection to the BMS. All associated wiring within the switchboard or panel board is to be carried out by the Contractor or the switchboard manufacturer and shall be routed to a terminal rail located within a compartment accessible when the switchboard is live without giving access to live parts other than those associated with the meter installation.

Meters will be supplied as part of the switchboards or panel boards and connected to the BMS by the BMS contractor. All necessary CT'S and voltage terminals to the same will be located in a segregated compartment from the ACB and MCCBs.

Current transformers shall comply with BS. 3938, and shall be a high accuracy specification. All instrumentation shall comply with the current edition of all appropriate British Standard publications
The instrumentation shall be flush mounted within the panel front of the switchboard, located immediately above the switches with which it is associated.

Current and voltage transformers shall be mounted within separate chambers within the switchboard or panel board. Transformers shall conform to BS EN 60044.

All meter shall conform to BS EN 62053 and to DIN 43700 style, minimum size 72mm square.

Ancillary fuses shall be labelled with the functions and operating details including fuse type and rating. All auxiliary wiring shall be labelled by permanent slip on numbered ferrules. Terminal blocks and terminations shall be similarly identified.

Meter board where required shall be 20mm thick resin bonded chip board.

6331005 Energy metering strategy

Energy metering shall be installed on all downstream distribution boards, chiller plant, electric humidifiers, motor control panels and mechanical services panels to comply with the metering strategy and as indicated on drawings. As a minimum, this shall provide the capability to identify energy used by all lighting and a minimum of 90% of the connected electrical load. The metering installation shall comply with the requirements of CIBSE TM39.

6332000 Power factor correction

6332001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Power factor correction equipment shall be suitable for operation from the supply voltage and frequency, including the tolerances specified in the particular requirements of this specification

Power factor correction equipment shall be provided to correct the power factor to the value specified in the particular requirements of this specification.

The complete power factor correction equipment assembly shall comply with all applicable requirements of this specification and shall incorporate adequate provision for connection to the general earth system.

Power factor correction equipment intended to be applied centrally or to specific groups of motors shall comprise a sufficient number of capacitor units to make up the specified capacitance, accommodated in a suitable cabinet or in a series of modular cubicles assembled together to form a composite unit, together with a control relay, switching equipment, protective fuses and means of isolation, all assembled and connected to as to control automatically the switching 'on' and 'off' of the capacitors in response to changes in the load power factor.

Each assembly and all of the equipment within it shall be so arranged that every item of apparatus is readily accessible for adjustment where this may be necessary, and for maintenance.

Each assembly shall be complete with incoming isolating switch of appropriate rating, HRC fuses, 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. Connection links shall be provided to permit easy removal or relocation of units and provision shall be made for extension at one or both ends of the busbar system.

Capacitors shall be of an established, proven design and two copies of type test certificates shall be submitted to the CA for comment.

Each capacitor unit shall comprise a balanced three phase system of capacitors.

Each capacitor stage shall be protected by BS EN 60269 fuses and be switched by a separate, block type contactor rated for capacitor switching duty (BS EN 60947 4 1).

Capacitors shall be self-healing type to IEC 60831-1. Capacitors shall consist of elements wound from metallised polypropylene film, vacuum processed and encapsulated in hermetically sealed containers. Each capacitor shall have overpressure operated disconnect fuse elements, in addition to overcurrent protection.

Capacitors shall be provided with discharge resistors to achieve full discharge within 60 sec. of disconnection. Capacitors shall have low loss per kVAr and be rated for a line current not less than 1.3 times the rated current. Means shall be provided to identify a failed capacitor or bank of capacitors. Units of equal capacitance shall be interchangeable

Space shall be left in the power factor correction equipment for the installation of de-tuning reactors should their use prove necessary in the future.

The control relay shall be suitable for operation from the existing current transformer(s) installed for the purpose in the main low-voltage switchboard as required by the P.F.C. manufacturer.

A microprocessor based reactive power controller shall be provided to control switching of the capacitor banks and allow rotation of use of the banks to uniformly distribute usage.

The controller shall ensure:

1. Automatic disconnection of all capacitors in the event of mains failure, with a two minute delay before re-connection
2. Target power factor setting adjustable from 0.8 lag to unity
3. Time delay between switching of stages to ensure capacitors are sufficiently discharged before re-energisation and to prevent hunting
4. Push button operated manual override incorporating time delay as above
5. Adjustable switching programmes
6. Incorporate normally open volt-free contacts for BMS indication of common alarm
7. Visible LED indication of capacitor stages
8. Disconnection on mains failure

Shrouding and large, clearly visible warning labels shall be provided within the enclosure to warn personnel of the need to discharge the equipment prior to any work.

Cable glands or sealing boxes shall be provided for the connection of incoming supply and control cables as specified.

Harmonic filters shall be provided where required to protect against damage from harmonic currents.

6341000 Light switches

6341001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

All low voltage lighting switches shall have interiors of the AC ‘quick-make, slow-break’ pattern, generally rated at 20 amp and manufactured in accordance with BS EN 60669 where relevant.

All switches shall be 1 way, 2 way or intermediate, as required, and in cases where they are grouped together and connected to the same phase, they shall be ganged together and mounted in a multi-gang box with a common switch plate.

All extra low voltage switches where fitted shall only be used as part of a proprietary system of equipment. No mixing of different manufacturer’s equipment will be permitted.

The finish shall be as indicated in the particular requirements of this specification and confirmed prior to order.

For all exterior situations, and in roof plantrooms, watertight switches shall be used comprising AC quick make and break pattern interiors with galvanised exteriors.

Where more than one phase is present at a light switch, the cover plate shall be engraved to indicate that 400V is present.

All switch plates shall be positioned from finished floor level in accordance with the mounting heights stated in the particular requirements of this specification.

6342000 Industrial socket outlets

6342001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Industrial socket-outlets shall comply with BS EN 60309 and unless indicated otherwise in the particular requirements of this specification, shall be switched. They shall be of the three, four or five pin shuttered female type mounted in appropriate boxes. All sockets shall be to a minimum of IP44 unless indicated otherwise in the particular requirements of this specification.

Sockets shall be colour coded to reflect the voltage they operate at.

1. Yellow shall be used where 110V is present
2. Blue shall be used where 230V is present
3. Red shall be used where 400V is present.

Socket outlets for general use or for use by ordinary persons shall be protected by 30mA RCD or combined RCBO devices which operate within the stated requirements of BS 7671.

Socket outlets for specific purposes shall be labelled with their use. Labels shall be clearly visible when a plug top is inserted and shall be durable such that they will not fade through exposure to sunlight or suffer due to abrasive wear. Where adhesive labels are used, the adhesive shall not degrade over time or exposure to sunlight, water or extremes of temperature.

All socket outlets shall be positioned from finished floor level in accordance with the mounting heights stated in the particular requirements of this specification.

6343000 Fused connection units

6343001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Connection units shall comply with BS 5733 and unless otherwise specified shall be double-pole switched and incorporate a BS 1362 fuse. They shall be mounted as required in the appropriate box.

All outlets shall incorporate red pilot lights. The pilot lights shall be recessed into the front plate of the outlets and shall comprise red lens, neon tubes and resistors in completely sealed units.

Connections for use with flexible cord shall have a cord outlet hole in the front or side of the font plate, with suitable flexi-grip enclosing for the cord.

Where the purpose of the connection unit is not clearly associated with the equipment it serves, a suitable label shall be fitted to indicate its function. Labels shall be durable such that they will not fade through exposure to sunlight or suffer due to abrasive wear. Where adhesive labels are used, the adhesive shall not degrade over time or exposure to sunlight, water or extremes of temperature.

The finish shall be as indicated in the particular requirements of this specification and confirmed prior to order.

All fused connection units shall be positioned from finished floor level in accordance with the mounting heights stated in the particular requirements of this specification.

6344000 Double pole switches and isolators

6344001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Double pole switches and isolators of 20A, 32A or 50A capacity (for interior non industrial use) shall comply with BS EN 60669. They shall be mounted as required in the appropriate box.

All double pole switches and isolators shall incorporate red pilot lights. The pilot lights shall be recessed into the front plate of the outlets and shall comprise red lens, neon tubes and resistors in completely sealed units.

Double pole switches and isolators for use with flexible cords shall have a cord outlet hole in the front or side of the front plate, with suitable flexi-grip restraint for the cord.

Where the purpose of the double pole switch or isolator is not clearly associated with the equipment it serves, a suitable label shall be fitted to indicate its function. Labels shall be durable such that they will not fade through exposure to sunlight or suffer due to abrasive wear. Where adhesive labels are used, the adhesive shall not degrade over time or exposure to sunlight, water or extremes of temperature.

The finish shall be as indicated in the particular requirements of this specification and confirmed prior to order.

All double pole switches and isolators shall be positioned from finished floor level in accordance with the mounting heights stated in the particular requirements of this specification.

6347000 13A socket outlets

6347001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

13 amp socket-outlets shall comply with BS 1363 and, unless otherwise specified, shall be switched. They shall be of the three-pin shuttered type mounted in appropriate boxes. The moulding shall possess high track-resisting qualities and conform to BS 1322.

The finish shall be as indicated in the particular requirements of this specification and confirmed prior to order.

Socket outlets for general use or for use by ordinary persons shall be protected by 30mA RCD or combined RCBO devices which operate within the stated requirements of BS 7671.

Socket outlets for specific purposes shall be labeled with their use. Labels shall be clearly visible when a plug top is inserted and shall be durable such that they will not fade through exposure to sunlight or suffer due to abrasive wear. Where adhesive labels are used, the adhesive shall not degrade over time or exposure to sunlight, water or extremes of temperature.

Where high protective conductor currents may exist, dual earth terminal socket outlets shall be installed.

All socket outlets shall be positioned from finished floor level in accordance with the mounting heights stated in the particular requirements of this specification.

6351000 Lighting – General requirements

6351001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Luminaires shall be suitable for their location.

Each type of luminaire other than decorative shall be supplied with a complete set of photometric data. For the purposes of this project, decorative luminaires shall only refer to those providing accent or ambience lighting and shall not form part of the general functional lighting design.

Where luminaires are supplied with prismatic or opal diffusers or controllers, they shall be UV and temperature stabilised to avoid degradation. Polypropylene luminaires or diffusers shall not be used.

Switch start fluorescent luminaires shall not be used.

LED luminaires shall be provided with photometric data in the same format as conventional lamps so that direct comparisons can be made.

6351002 Construction

Luminaires shall be rigidly constructed in corrosion-proof materials and designed not to distort when suspended or installed.

Lamp holders shall be formed of insulated high temperature mouldings rigidly mounted on the luminaire body.

The cable terminations shall be fixed in the lampholder in such a way that the plunger contacts maintain free movement and no strain is placed on the cables.

All luminaires shall be finished pure white internally.

All low voltage tungsten capsule or dichroic lamp luminaires shall be of a construction suitable to dissipate the heat generated by the lamp without causing damage to the supporting ceiling.

Luminaires that are for decorative purpose shall be to an approved finish although the general standard of construction shall be of that already indicated.

All luminaires shall be supplied incorporating full provision for support, located in the appropriate places and allowing full adjustment of mounting, compressing, fusing holes and brackets as most suitable.

The luminaire enclosures shall permit full access to any component for maintenance without unnecessarily disturbing other components and without the removal of the luminaire or adjacent finishes.

Each luminaire shall incorporate provision for circuit cable and conduit entry comprising an entry standardised to BS 4568 and 20mm conduit piercing, made in the centre of the luminaire or control box back, singly for square luminaires, but dual in-line for linear luminaires. Luminaires for mounting on suspended ceiling shall have their entries together on a detachable plate mounting the main terminal block such that each luminaire can be readily detached without disturbing the looping-in circuit wiring system. A plug and socket system shall be used for this purpose.

All high pressure discharge luminaires shall have lamp covers fitted or be supplied with lamps which will not shatter on lamp failure.

All diffusers and prismatic controllers shall be of a material which does not suffer from ultra violet degradation.

Photometric data for all luminaires used in the installation shall be provided.

6351003 Control gear and wiring

All discharge control gear shall be designed for continuous operation.

All control gear shall be rigidly mounted and shall be provided with shrouded terminals. The wiring within the luminaires shall comprise of high temperature PVC insulated stranded copper cables of such diameter that there is negligible volt drop.

A terminal block shall be provided for the incoming supply cables and the metallic content of the luminaire shall be electrically connected to an earthing terminal. Each terminal block shall have an integral fuse.

Discharge and fluorescent lamp ballasts shall be of the high frequency electronic type, suitable for luminaire daylight control and dimming. They shall also be suitable for automatic presence/absence switching without causing a reduction in lamp life. Each ballast shall have individual control connections and shall be enclosed in a resin filled sheet metal canister. Ballasts for tubular low-pressure discharge lamps shall comply with relevant British Standards.

Capacitors shall be of coiled metallised film construction and enclosed within insulant filled sheet metal canisters. They shall be rupture and leak-proof and shall comply with BS EN 61048 and BS EN 61049.

All ballasts shall be high temperature with a rating of 120°C and capacitors shall be rated at100°C.

6351004 Internal wiring

All wiring to the control gear shall be carried out in a minimum of 0.75mm^2, high temperature PVC insulated conductors, with a continuous rating of 105ºC. The wiring shall end in a jack plug type fused terminal block mounted on the gear tray. The lamp holders to be bi-pin push-on type, with lamp clips mounted on the canopy or alternatively end caps supported from the luminaire housing.

Luminaires shall not be through wired unless specifically designed for the purpose.

6351005 Luminaire selection and design

Luminaires shall be selected and set out as detailed on the drawings and as stated elsewhere.

The emitted luminous flux from enclosed light source(s) of each luminaire shall be controlled and redistributed by an efficient optical system which shall effectively direct the light towards the working plane and away from the normal viewing angles, and reduce the subjective luminosity (glare).

6351006 Luminaire noise

All luminaires shall be designed to keep within the noise criteria specified in the relevant British Standard.

6351007 Lamp holders

Lamp holders for use with bayonet cap or Edison screw lamps shall be category T2 to BS EN 61184 and shall be suitable for use with the type of lamp cap specified. Ceiling roses shall comply with BS 67 and shall be complete with halo. BS lamp holders shall be of the type that have isolated contact pins when the lamp is removed.

All lampholders shall be capable of accepting compact fluorescent lamps with either bayonet cap or Edison screw connectors as appropriate.

Lamp holders for use with linear and compact fluorescent lamps shall be bi-pin type complying with BS EN 60400.

Lamp holders for use with low voltage tungsten halogen lamps shall be suitable for the temperatures generated by the associated lamp.

Lamp holders for use with compact fluorescent lamps shall be capable of withstanding the heat generated by the associated lamp on a continuous operation basis without suffering any thermal or ultra violet related damage.

Pendant drops prepared by the installer shall include moulded insulated cord grip, skirted lamp holders. The cable terminals shall be fixed in lamp holder so that the operation of the 'plunger' contacts shall not move the terminals. Lamp holders shall be fitted with skirts that allow compact fluorescent alternatives to be used. All lamp holders and ceiling roses shall be self-finished in white.

All lamp holders incorporated in enclosed luminaires shall have suitable thermally rated construction for continuous operation.

6351008 Lamps

All luminaires shall be complete with the correct number and size of lamp indicated on the layout drawings, and lamps shall be suitable for the nominal voltage applicable. At handover all lamps shall be new.

Tungsten filament lamps shall not be used. Compact fluorescent alternatives are to be used where conventional lamp holders are installed.

Fluorescent lamps shall be to BS EN 60081 and BS 1853: Part 2 and amendments, and of the appropriate colour as specified elsewhere.

Where mixed batches of lamps are used, the contractor shall ensure colour variances do not occur. Where not specified elsewhere, all linear and compact fluorescent lamps shall be colour 4000K

Metal halide lamps shall be of the ceramic filament type to reduce the risk of colour drift common to this type of lamp.

All high-pressure mercury vapour lamps shall comply with BS EN 60188 and shall be suitable for burning in a horizontal and vertical position.

Where circuits supplying high pressure discharge lamps of any kind are protected by MCB, the operating characteristics and rating of the MCB shall be suitable for the load.

All low-pressure sodium lamps shall comply with BS EN 60192

Low voltage tungsten capsule or dichroic lamps shall only be used where no other reasonable alternative is viable.

6351009 Luminaire Efficacy

All luminaires including LED luminaires shall have an efficacy of not less than those quoted in the HM Government Non Domestic Building Services Compliance Guide – Current Edition

6351010 Plug-in ceiling roses (PCR)

All luminaires recessed into suspended ceilings shall be connected by means of a PCR. The PCR shall be mounted on a circular conduit box and shall comprise a three-pin or four-

pin 2 amp socket and plug with a coarse screw moulded plug retaining cover. The PCR shall be located within 500mm of the luminaire and connected via a suitable flexible cord.

Four-pin PCR's shall be utilised for luminaires with integral emergency lighting facilities.

6351011 Flexible cables and cords

All flexible cables and cords shall comply with BS 6500 and BS 6004. Cables shall be 300/500V grade PVC, rubber or LSF insulated and sheathed as appropriate.

The application of the temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature.

Where an earthing conductor is required for the earthing of metalwork in apparatus and luminaire, it shall be contained within the flexible cable or cord.

Flexible cables and cords for use with lighting pendants and electric lighting fittings

Flexible cords for use with lighting pendants employing compact fluorescent lamps shall be heat resisting PVC or Butyl rubber or EP rubber insulated and shall comply with BS 6500 Table 12 or 14.

Flexible cords for use with luminaires employing tubular fluorescent lamps or apparatus operating at normal room temperature shall be PVC insulated and sheathed and shall comply with BS6500 Table 6 or 11.

6351012 Lighting installation

Modular wiring systems shall be permitted provided that compliance with BS7671 (current revision) can be established.

Modular systems shall be wired using cables suitably rated to run in containment with general wiring. Cables are to have LSF outer sheath. Where systems utilise a marshalling box for radial distribution to luminaires, switches and PIRs, the cables between the items shall be supported so as to not lay on the back of ceilings.

Modular systems shall be factory assembled with no terminating of plugs/sockets etc on site. Excessive cable loops will not be accepted. The system cable lengths shall be measured carefully prior to order to ensure cables lengths are not excessive.

For conventional installations, final connection of wiring to luminaires shall commence from the outlet box into which the hard wiring is terminated on suitable thermally rated terminals. Final connection to fluorescent luminaires shall be as specified for flexible cords. The installer shall take all necessary precautions to prevent overheating of cables and components, which shall be suitable for the operating temperatures involved. On no account shall hard PVC wiring be drawn into luminaires. All wiring connections shall be terminal type with suitable thermally rated insulation. Single Screw type connectors must on no account be used.

All discharge and fluorescent luminaires shall be fitted with integral cartridge fuses incorporated in the mains connector block which shall be moulded plastic insulated pattern.

Surface mounted luminaires shall be mounted direct on to flush conduit installations, where a terminal circular conduit box shall be provided. Where surface conduit has been provided the luminaire shall be fixed direct to the ceiling soffit and connected via a side or end entry conduit box.

Suspended luminaires (non-decorative) shall be supported by one of two methods. Either 20mm steel conduit attached to the ceiling outlet box with a ball socket pattern ceiling plate or via a hooked conduit plate and galvanised jack chain. A braided copper link shall be fitted inside the ceiling plate to ensure earth continuity where a ball and socket connection is used.

Recessed luminaires shall be attached directly to the suspended ceiling where permitted. Where the ceilings are plaster, the installer shall install suitable flanged trims to the openings prior to plastering. Recessed luminaires shall be connected via a PCR and flexible cable installed on a conduit outlet box within 500mm of the luminaire. 1m of flex shall be allowed for the luminaire connection to allow some later movement in the ceiling grid.

Where low voltage dichroic (or similar) luminaires are to be provided within timber ceilings, fireproof panels shall be fixed by the installer above the luminaire, whenever the space between the top of the lamp holder and the timber is 200mm or less.

External luminaires and vapour-proof luminaires shall be installed with suitable gaskets on all openings to ensure the integrity of the installation. All fixings and supports in these situations shall be zinc plated, brass, or stainless steel as stated on the drawings or elsewhere.

Reflectors and louvres shall only be installed when all dirty trades work is completed and the contractor shall take care not to get fingerprints, marks, etc on the reflective surface (gloves may be required).

At the time of practical completion, the installer shall clean all luminaires thoroughly to remove dust and fingerprints and ensure all lamps are in working order and of the correct wattage and type specified.

6351013 Maintenance factor

The criteria for maintenance factor is given in section 2004000

6352000 Floodlighting

6352001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Specifically, this section should be read in conjunction with the section on lighting general requirements.

Floodlights shall be constructed in such a way as to ensure they are capable of continuous operation. Where control gear is incorporated within the luminaire body, suitable heat sinks shall be provided which may be incorporated into the luminaire body itself.

Floodlights shall be installed in the orientation approved by the manufacturer. Where it is intended to install floodlights in an inverted position, approval of this proposal shall first be obtained from the equipment manufacturer.

High pressure discharge floodlights used in areas where the loss of illumination during re strike periods in unacceptable, shall be fitted with pilot lamps as indicated on drawings or in the particular requirements of this specification.

6352002 Floodlights with symmetric distribution

Floodlighting with symmetrical distribution reflectors shall not be use externally due to their poor control of the upward light component. Where used internally, symmetric floodlights shall be carefully mounted so as to optimize their output.

Symmetric floodlights shall not be offered or installed as alternatives to asymmetric floodlights.

6352003 Floodlights with asymmetric distribution

Floodlighting with asymmetric distribution shall be used externally. Luminaires shall be carefully positioned to maximize the effect of the asymmetric reflector and to minimize the upward light component.

The contractor shall allow for a separate commissioning exercise by a suitably qualified lighting professional during the hours of darkness to demonstrate the correct positioning.

6357000 Linear fluorescent luminaires

6357001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Specifically, this section should be read in conjunction with the section on lighting general requirements

6357002 Batten luminaires

Batten luminaires shall be fitted with acrylic or polycarbonate prismatic controllers. Bare batten luminaires shall not be used unless specifically stated in the particular requirements of this specification, or on accompanying drawings.

Polypropylene controllers or diffusers shall not be used.

6357003 Surface modular luminaires

Surface modular luminaires shall be of steel construction with a pure white finish unless stated otherwise in particular requirements of this specification or on drawings.

Where fitted with mirror or satin louvres, these shall be fully fitted types which allow no light leakage around the body edges.

6357004 Recessed modular luminaires

Recessed modular luminaires shall be of steel construction and fully boxed with a pure white finish unless stated otherwise in particular requirements of this specification or on drawings.

Luminaires shall be supplied with all mounting accessories and shall only be supported (lay in type) from the ceiling grid if the ceiling is designed for this purpose.

Where fitted with mirror or satin louvres, these shall be fully fitted types which allow no light leakage around the body edges.

6358000 Self-contained emergency lighting

6358001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Specifically, this section should be read in conjunction with the section on lighting general requirements

Emergency lighting installations shall be as shown on the drawings and as detailed in the particular requirements of this specification. The system shall conform to BS 5266-1 and BS EN 1838 (also numbered BS 5266-7).

Luminaires for use on emergency lighting systems shall comply with BS EN 60598-2-22. Self-contained luminaires shall be ICEL approved and suitable for 3-hour operation.

All luminaires shall be purpose made manufacturers equipment, properly tested and certified by the manufacturer. On-site conversion of mains luminaires with emergency battery kits by other manufacturers will not be acceptable.

Emergency lighting shall be provided in all areas necessary, including exits and external escape and assembly areas.

The installation shall comply with BS 7671 Requirements for Electrical Installations.

6358002 Self-contained emergency luminaires

Where mains luminaires are converted to emergency operation using inverter and battery packs, they shall be factory fitted in accordance with ICEL recommendations and the manufacturer's requirements. In particular, attention shall be paid to the location of the batteries with regard to the effects of high temperatures from luminaire control gear, etc, and that charge indicator LED's are clearly visible with the luminaire in position.

If converted luminaires involve the use of remote mounted batteries or inverter packs; these shall preferably be mounted within 500mm of the luminaire within steel enclosures fixed to the soffit or walls, or on a suitable bracket. Cabling between inverter/battery packs and luminaires shall be the same as wiring for central battery systems. Inverter/battery packs shall not be laid unfixed on the back of ceilings. A readily removable access opening shall be provided for local access to battery packs mounted remotely in voids.

Wiring to self-contained luminaires shall be the same standard as the local normal lighting circuits. A local key test switch shall be provided in a convenient location for each emergency lighting circuit.

6858003 Self-contained “self-test” emergency lighting

Where self-test luminaires are specified, the fittings shall employ an indicator system based on LEDs. The LED colours used and sequencing of fault indication shall be common throughout the project so as to avoid confusion during maintenance.

6358004 Centralised and remote monitoring of emergency lighting

Centralised, remote and TCP/IP based monitoring systems where installed shall be compatible with, and capable of monitoring self-contained luminaires. They shall be manufactured and installed to comply with the requirements of BS5266 and BS EN 62034.

The system shall be capable of monitoring fittings up to 1km away from the control panel or access point. Systems shall be modular to allow for the expansion of the system in future and shall be capable of monitoring at least 10,000 luminaires with information recorded per luminaire.

The system shall be capable of running automatic testing procedures in accordance with current legislation.

Failure of any individual device within the system will not cause failure of any other part of the system to operate.

Systems shall be capable of raising alarm both audibly, visually and remotely for system faults, lamp fail, lamp removal, test fail and test fail to start.

6358005 6.6 Commissioning

The whole system shall be tested by a person deemed competent by the installer and by the enforcing authority or the CA.

A test certificate in accordance with BS 5266 Part 1 Appendix A, shall be issued to the CA for including in the operating and maintenance documentation.

6360000 Internal LED luminaires

6360001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Specifically, this section should be read in conjunction with the section on lighting general requirements

6360002 Supply LED luminaires complete with photometrics for the complete luminaire package tested at 25°C ambient. Photometrics for component LED drivers, independent of the proposed luminaire will not be accepted.

Photometrics produced at lower temperatures will not be accepted unless the luminaire is intended to be installed in a location which is intentionally and permanently cooled to a lower level.

6360003 LED luminaires shall be designed specifically to be used with the associated driver. Luminaire bodies designed originally for use with fluorescent or compact fluorescent lamps and control gear shall not be used.

6360004 LED luminaires shall not exhibit any noticeable flicker and shall have an operating frequency in excess of 600Hz.

6360005 Glare from LED luminaires shall meet the same criteria as for fluorescent and compact fluorescent luminaires such that in application they meet the unified glare rating (UGR) in the relevant SLL Guide for their intended use.

6360006 LED luminaires shall be of the latest generation at the time of purchase. Provide evidence that the luminaire and any part of it, including the LED driver and array was manufactured not more than 3 months prior to the date of purchase.

6360007 Where alternatives are offered, provide evidence that the alternative offer matches or exceeds the original luminaire in terms of LED efficiency, luminaire lumen output at 25°C ambient, spacing to height ratio and glare control.

6361000 External LED luminaires

6361001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Specifically, this section should be read in conjunction with the section on lighting general requirements

16361002 Supply LED luminaires complete with photometrics for the complete luminaire package tested over a range of -10°C to +20°C. Photometrics for component LED drivers, independent of the proposed luminaire will not be accepted.

Photometrics produced at lower or higher temperatures will not be accepted unless the luminaire is intended to be installed in a location for which the test temperature is relative.

6361003 LED luminaires shall be designed specifically to be used with the associated driver. Luminaire bodies designed originally for use with fluorescent, compact fluorescent, or high pressure discharge lamps and control gear shall not be used.

6361004 LED luminaires shall not exhibit any noticeable flicker and shall have an operating frequency in excess of 600Hz.

6361005 LED luminaires shall be of the latest generation at the time of purchase. Provide evidence that the luminaire and any part of it, including the LED driver and array was manufactured not more than 3 months prior to the date of purchase.

6361006 Where alternatives are offered, provide evidence that the alternative offer matches or exceeds the original luminaire in terms of LED efficiency, luminaire lumen output at prescribed ambient temperature, spacing to height ratio and glare control.

6370000 Earthing

6370001 General requirements

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Where pipes etc are to be bonded, the cable shall be connected to an adjustable metal clamp complying with latest standards for use with variable sizes of water and/or gas pipe.

Approved warning labels shall be fixed to each earth termination or bonding connection to structural steel, water or gas pipes etc, durably marked with the words *'Safety Electrical Connections – Do Not Remove'.*

Where metal conduit, trunking, cable sheaths and/or armouring is employed as part of the earthing system all joints, terminations and connections shall be constructed to afford a low impedance path for fault currents. All joints and connections shall be suitably protected to prevent deterioration caused by bi-metallic or other corrosion. The cross sectional area of the material shall comply with the requirements of BS 7671.

Mechanical joints between aluminium and copper shall have the joint faces lightly coated with a suitable compound to prevent corrosion, before the connection is made.

The armouring of plastic sheathed cables shall terminate in a suitable compression gland fitted with a purpose made earth tag. A suitable protective conductor shall connect the earth tag to the apparatus earthing terminal. The earth tag shall be manufactured from a high conductivity material compatible with the cable gland.

The armouring of metal sheathed cables shall be securely clamped to the gland at the cable termination with a purpose made bolted clamp. A suitably sized protective conductor shall be installed to connect the armour clamp or gland to the apparatus earthing terminal.

For an outdoor termination, the armouring shall be suitably protected to prevent corrosion.

Where metal sheathed and/or armoured single core cables are employed, bonding conductors shall be installed at each end of the cable run and connected to the apparatus earthing terminal. These bonds shall effectively connect the sheaths and/or armouring of the single core cables where they leave trefoil formation. Cable glands in such circumstances shall be lightly insulated to prevent circulating sheath currents. Where the cable run does not exceed 10m, only one bond shall be installed, to earth the cable sheath and/or armouring.

Metal sheaths and/or armouring of multi-core cables connected to a cubicle-type switchboard shall be effectively connected to the switchboard earth bar as described elsewhere in this specification.

Where armoured multi-core cables are terminated on a unit motor starter panel or local disconnector a separate protective conductor shall connect the incoming and outgoing armouring to the starter panel or disconnector earthing terminal. Similarly, the motor frame shall be connected to the cable armouring or the starter panel or local disconnector whichever is more convenient.

Where flexible conduits are installed a suitable green/yellow LSF insulated protective conductor shall be installed and connected to the equipment at each end of the flexible connection.

The earth terminal of all socket-outlets shall be connected to the protective conductor of the final circuit. Where the protective conductor is formed by conduit, trunking or the metal sheath and/or armouring of cables the earth terminal of the socket-outlet shall be connected to an earth terminal in the box or enclosure associated with the conduit, trunking or cable.

Joints in cable runs will not be permitted.

6371000 Main earth terminals

6371001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

A main earth bar, mounted on insulators, shall be located in a convenient position in the switchroom and shall be drilled to accept copper tape and insulated standard conductors. The earth bar shall be rated in accordance with BS 7430 with a minimum size of 60mm x 6mm. It shall be at least 500 mm long.

The main earth bar shall be provided with two 100% rated main earthing lead connections. Disconnecting test links shall be provided to allow periodic testing of a live installation. The requirements of the main earth bar shall be as detailed elsewhere.

Where a combined HV/LV earthing system is installed, copper tape shall be run to connect the transformer frames, HV switchgear frames, any fences, gates, etc., and the LV switchgear frames.

6372000 Dedicated earths

6372001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Where a ‘dedicated’ earth system is specified it shall be derived directly from the main earth bar and only connected to earth at that point and at no other point throughout its entirety. The connection shall be made through a disconnecting test link. A white engraved label with the legend “dedicated earth” (along with its specific application) in 25mm orange lettering shall be provided in a prominent position above the test link.

The ‘dedicated’ earth connections shall be made using cream coloured LSF insulated single core cables of the sizes detailed in BS 7671.

Protective earth functions must take priority however and any combined ‘dedicated’/protective conductor shall be coloured green/yellow.

6373000 Earth electrodes and pits

6373001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Earth electrodes shall be copper clad steel, complete with all drive type heads, connectors, and cable clamps. The number, locations and depth of installation shall be as shown on drawings or in particular information within this specification.

Each earth rod shall be protected by a purpose made enclosure that is accessible for testing and maintenance purposes.

Where the earth rod is internal to the building, the enclosure can be formed in the floor structure, with a load bearing cover. It shall be of a proprietary manufactured sealed type, to prevent water ingress. The rod shall pass through a 75mm diameter tube that has been cast into the floor structure. The top of the 75mm diameter tube shall be sealed with a non-hardening mastic compound and a sealing gland assembly to prevent the ingress of water into the earth pit.

6374000 Earthing for HV/LV transformers

6374001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Where the transformer(s) are owned by the DNO, a measured external earth loop impedance shall be obtained for the LV earth before the work on site commences. The proximity of the HV earthing arrangement to any planned LV earthing arrangement shall be determined and where necessary, the power frequency stress voltage during a HV fault to earth shall be calculated in accordance with BS 7671 Regulation 442.2.

Where the transformer(s) are part of a private network, the earth system shall comprise of either low resistance earth electrodes or a suitable low resistance copper earth mat. The arrangement of earth networks shall be shown on the appropriate drawing and may include combined HV and LV earthing or separate systems, depending on the requirements of the site.

All extraneous metalwork associated within the HV and LV installations shall be bonded to the appropriate system.

For LV earth networks, the earth electrode system(s) shall consist of driven copper clad steel rods or copper strips laid in formed trenches. The earth resistance shall not exceed 1 ohm before interconnection with the building metal work, cable armour, etc.

Transformers installed internally within buildings shall have their LV earth network bonded to slab re bar.

Insulated stranded cables shall be run to the transformer neutrals via the LV switchboard neutral busbar and to the earth electrodes.

For HV earth networks, the earth electrode system(s) shall also consist of driven copper clad steel rods or copper strips laid in formed trenches. The earth resistance shall not exceed 1 ohm before interconnection with the transformer core.

The size of all cables and tapes shall be as detailed on the drawings

6375000 Equipotential and supplementary bonding

6375001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Equipotential and supplementary bonding shall be installed in accordance with BS 7671.

Equipotential bonding in bathrooms shall be carried out regardless of the fact that circuits are protected by RCD or RCBO to ensure the installation remains safe in the event of RCD or RCBO failure.

6377000 Protective multiple earthing (PME)

6377001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Where a PME earthing terminal is provided by the DNO, the consumers PME bonding shall be installed between the earthing terminal and all other incoming metallic services, at a point as close as practicable to the point where each service enters the building.

Metalwork forming part of a telegraphic, telephone or signaling circuit need not be bonded as part of the safety earth system.

The minimum size of the consumer PME bonding is related to the size of the service cable and shall be as required by the PME regulations.

The earthing connections shall be made using single core cables with LSF insulation coloured green/yellow.

Approved warning labels shall be fixed to each connection suitably marked with the words ‘Safety Electrical connection - Do Not Remove’.

The final termination of the PME terminal will be carried out by the DNO.

6378000 Lightning protection

6378001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

Lightning protection systems shall be designed, installed and tested in accordance with the requirements of BS EN 62305 and BS 7430.

The system shall comprise of an air termination(s), down conductor(s), testing joint(s), earth termination(s) and earth electrode(s). Steel reinforcing in columns may be used subject to the main contractor confirming there are:

1. Sufficient vertical paths to earth to allow compliance with BS EN 62305
2. Sufficient metalwork enclosed within the structure so that touch voltages during a lightning strike will be below the maximum level given in BS EN 62305.

The materials for the component parts of the lightning protective system shall be those detailed in BS EN 62305. Care shall be taken in the selection of bonding clamps to prevent corrosion from the action of dissimilar metals.

The installer shall take full account of the environmental conditions at the site and the materials used in the building construction to supply a lightning protection system that will provide trouble-free life of at least 25 years.

All components shall be from one manufacturer.

The installer shall submit technical details of the system, including fixings, materials, etc to the CA for comment on the architectural and coordination issues associated with the installation.

Metallic roofing and cladding shall be verified as being electrically continuous and bonded to the lightning protection system.

Dependent on the type of system specified elsewhere, all metallic projections and plant or equipment on or above the main surface of the roof structure shall either be bonded to the lightning protection system or provided with a secondary metallic structure mounted either adjacent or above the equipment which will then be connected to the lightning protection system. All bonding connections shall be covered in grease to prevent corrosion.

Conductors shall be run parallel and perpendicular to the structure.

Any extended metal running vertically through the structure shall be bonded to the lightning conductor at the top and bottom, unless the clearances are in accordance with BS EN 62305.

Where the foundations or piles, etc. are being used as the earth termination network for the lightning protection scheme, reference electrodes shall be installed for periodic monitoring of the condition of the network.

All underground joints shall be carried out using an exothermic process and protected against corrosion. Above ground joints shall be made using gunmetal or phosphor bronze fittings and fixtures. All above ground joints shall be accessible for inspection.

Joints between dissimilar metals shall be protected by proprietary inhibitor paste and taped with bitumastic bandage to prevent corrosion as agreed with the CA.

Any building weatherproofing shall not be impaired.

Testing joints shall be provided in a convenient position for testing, approximately 1 metre above ground level.

Earth electrodes shall consist of metal rods or tapes or a combination of both as directed by the CA.

Earth impedance testing shall be carried out during the construction so as to ensure earthing impedance for each earth complies with BS EN 62305 and BS 7430.

Bonds to extraneous metalwork shall be carried out individually to each element such that the disconnection of any bond shall not affect the earthing of any other element of the system.
The method of connections to structural steelwork shall be agreed with the structural engineer and CA prior to commencement of the works.

The installer shall test the continuity of the structural steel work throughout the building and provide additional bonding where necessary.

On completion of the installation, the whole system shall be tested in accordance with BS EN 62305. Copies of the test results shall be forwarded to the CA for approval.

The installer shall allow for a retest of the system prior to the expiry of the defects liability period and as agreed with the CA.

Section 7000000 – Electronic engineering services

7301000 Fire alarm systems

7301001 General

Comply with the requirements of this and other sections of the specification as well as associated drawings and schedules.

The fire alarm systems shall be provided as shown on the drawings and as specified elsewhere and shall conform to the requirements of BS 5839 and BS EN 54 (all current parts as applicable)

The design is provided at scheme level and detail design along with supply, installation and commissioning shall be carried out by the contractor via the Trust's preferred fire alarm manufacturer / installer. This will allow the design to be optimised to the Trust's requirements.

Fire detection and alarm systems are divided into three categories, as described in BS 5839 – Part 1. These categories are: -

Category L : Automatically activated systems that are designed to protect life.

L1 - Systems installed throughout the protected building.
L2 - Systems installed only in defined parts of the protected building.
L3 - Systems installed only for the protection of escape routes.
L4 - Systems installed in circulation areas used for as escape routes.
L5 - Systems installed to satisfy specific fire safety objectives.

Category M : Manually operated systems (no sub-categories)

Category P : Automatically activated systems designed to protect property

P1 - Systems installed throughout the protected building.
P2 - Systems installed only in defined parts of the protected building.

A similar categorization system for dwellings is described in BS 5839 – Part 6.

The category designation for the fire detection and alarm system to be installed will be as stated in the particular requirements of this specification.

7301002 System types

The table below gives an overview of system types

Type	Description
Manual system	A system which relies on persons detecting a fire and using the fire alarm system to raise awareness to all in the building.
Conventional monitored	A system where detectors, manual call points and sounders are wired as radial circuits with an end of line device. The fire alarm system monitors output states "normal" or "fire" as well as "fault".
Analogue or digital addressable	A multi-state system in which signals from devices are individually identified at the control and indicating panel(s). The system is wired as a loop or series of loops, dependent on the complexity of the installation.
Radio based system	A system where some or all of the interconnections between components are made by radio links.
Aspirating System	A system which monitors the particulates within the air and raises an alarm if the level of smoke particulates goes above a pre-determined level.

The system type (or types depending on the complexity of the design) for the fire detection and alarm system to be installed will be stated in the particular requirements of this specification.

7301003 Manual call points

Manual call points shall comply with BS EN 54-11 for “Type A” operation i.e. Direct Operation.

Manual call points shall be coloured “Red” with a frangible element covering the push button. Manual call points shall be clearly labeled with the text “FIRE”.

Manual call points shall be mounted no higher than 1200mm AFFL and in compliance with the Disability Discrimination Act. The contractor shall obtain final written approval from the Building Control Officer (BCO) prior to installation.

Manual call points shall be flush or surface mounted to suit adjacent accessories.

7301004 Heat detectors

Heat detectors shall comply with BS EN 54-5.

Heat detectors may be point type or line type detectors as indicated on the drawings

7301005 Point type smoke detectors

Point type smoke detectors shall comply with BS EN 54-7.
Smoke detectors shall be either ionisation chamber type or optical beam type as indicated on the drawings. Optical beam types, being the most resilient to false alarm, shall be the preferred type unless a particular risk dictates the need for ionisation detectors.

7301006 Beam type smoke detectors

Beam type smoke detectors shall comply with BS EN 54-12
Smoke detectors shall be infra-red type using either a separate transmitter and receiver or a combined transmitter/receiver unit with optical reflector. Regardless of which type is used, the detectors shall be capable of operating distances up to 100 metres and shall incorporate the facility to accept building movement which misaligns the receiver/transmitter or receiver/transmitter and reflector by up to 100mm in any direction.

7301007 Multi sensor detectors

Multi-sensor detectors shall comply with BS EN 54-5, 54-7 and 54-17.

The detector shall comprise a combination of the following sensors: -

1. Optical Smoke.
2. Heat (fixed temperature).
3. Carbon Monoxide

Each sensor element shall be capable of being programmed with different enabled / disabled time periods enabling a reduction in false alarms.

7301008 Flame detectors

Flame detectors shall comply with BS EN 54-10.

Detectors shall be either individual infra-red (IR) or ultraviolet (UV) types and if the risk dictates the need, combined UV/IR detectors as indicated on the drawings.

7301009 Aspirating systems

Aspirating systems shall comply with BS EN 54-20.
Where specified, aspirating systems shall be used either in place of/or in addition to conventional or addressable fire alarm systems.

7301010 Video smoke detection

Video smoke detection is an emerging technology which utilises the CCTV system within a building to detect the presence of smoke. Where specified, the system(s) shall be used as part of a fire engineered (performance based) design and shall be in accordance with the fire engineer's strategy. The system shall be designed, supplied, installed and commissioned by the contractor.

7301011 Sounders

Fire alarm sounders shall comply with BS EN 54-3.
The minimum sound pressure levels (dBA) shall be in accordance with BS 5839-1 and shall not fall below the figures given below

Location	Min dB(A)	Max dB(A)
General Areas	65	120
Stairways	65	120
Areas of limited extent	62	120
Bedhead	75	120
Hospital Accommodation	45	55

An area of limited extent shall be any localised area within a larger space which shows a drop off in sound pressure level from 65dB(A).

7301012 Visual alarms

All visual alarms will be provided in accordance with BS5839-1 and BS EN 54-23 and shall be either xenon beacons or twin large area LED type. The visual alarms shall be supplemented with a low sound level buzzer or external sounder, if specified in the particular requirements of this specification.
As a minimum, visual alarms shall be installed within the following areas as required by Part M of the Approved Building Regulations: -

1. Toilets (Staff / Public).
2. Changing Rooms.
3. Shower Rooms.
4. Plantrooms / Boiler Rooms.

Any additional area identified by risk assessment which may not be suitably covered by sounders alone.

Where the background sound levels are particularly high and visual alarms cannot be relied upon, consideration shall be given to removing the source of noise on fire alarm. (eg remove power to audio equipment in a nightclub on fire alarm activation)

7301013 Portable alarms

Portable alarms shall be provided in accordance with BS5839-1. The portable alarm device shall be a radio pager complete with integrated vibrating function, tactile messaging and LCD text messaging.

7301014 Control and indicating equipment

Control and indicating equipment shall comply with BS 5839-1 and BS EN 54-2.

Fault Monitoring
The control and indicating equipment shall monitor the following faults as a minimum: -

1. Short circuit in any circuit serving manual call points or detectors.
2. Open circuit in any circuit serving manual call points or detectors.
3. Removal of any manual call point or detector that is designed to be detachable.
4. Short circuit of any circuits serving fire alarm devices.
5. Open circuit of any circuits serving fire alarm devices.
6. Short circuit / open circuit of any wiring between power supplies and fire alarm devices.
7. Any earth fault condition.
8. Any operation of circuit protective device serving any fire alarm device.

A fault indication should be given, within the times stated below.

Fault	Duration
Failure of the main power supply	Within 30 minutes
Failure of the standby power supply	Within 15 minutes
Failure of battery charger	Within 30 minutes
Failure of batteries	Within 30 minutes

A zone diagram shall be fitted adjacent to each control panel in accordance with BS 5839 Part 1. The diagram should be framed and constructed to a standard suitable for its environment.

7301015 Power Supplies

Power supply units shall comply with BS EN 54-4

The power supplies shall normally be 24 volts DC derived from the mains via bridge rectifier / transformer equipment, but in the event of a mains failure the system shall operate from a battery system for a minimum of 24 hours, after which there should be sufficient capacity to operate the sounders for 30 minutes.

7301016 Remote Signalling

Remote signalling to alarm monitoring centres, such as RedCare shall be provided in accordance with BS 5979 if stated as a particular requirement elsewhere in this specification.

7301017 Fire alarm interfaces

The fire alarm system shall be interfaced to the following equipment to ensure the operation as described: -

1. Lift Control Panel – The lift car parks at Ground floor level (or as indicated in the fire strategy) and locks “out of service” during fire evacuation.
2. Mechanical Control Panel – Ventilation plant shuts down during fire evacuation (or enters a pred-etermined mode as dictated by the fire strategy).
3. Access Control Doors – Access control doors on escape routes at automatically unlocked (unless pre-determined requirements indicate an alternative course of action).
4. Door Détentes – Fire doors automatically close during fire evacuation.
5. PA equipment including voice alarm control panels

7301018 Wiring

The fire alarm system will be wired using either MICS or “enhanced” grade fire resistant “soft skin”cable in accordance with BS 5839-1. Where there are particular requirements to use a specific cable type, this is identified in the particular requirements of this specification or on drawings.

Mixture of cable types will not be permitted. Cables shall only be supplied from one manufacturer for the entire system to avoid known impedance problems caused by mixing different manufacturers cables.

Where used, the enhanced fire resistant cable will meet the PH120 classification when tested in accordance with EN 50200.

Cable used for power supplies to fire alarm panels, repeater panels or auxiliary power supplies shall have a minimum PH120 rating and be in accordance with BS 8519 Category 3.

The minimum cross sectional area of the fire alarm cables shall not be less than 1.5mm2.

The fire alarm cable shall have a LSZH outer sheath, preferably coloured red. Other colours may only be used if specified in the particular requirements of this specification or identified on associated drawings.

7301019 Installation and test

The fire alarm system shall be installed and tested in accordance with the requirements stated in BS5839-1.

Plastic cable ties shall not be used unless the cable is laid on the upper side of either cable basket or cable tray such that the cables weight is fully supported by the basket or tray and the cable ties are only used to secure the cable in place.

7301020 Commissioning and handover

The fire alarm system shall be commissioned in accordance with the requirements stated in BS5839-1. The commissioning engineer shall measure and record sound level readings.

7301021 Documentation

In accordance with BS5839-1 the fire alarm installer shall provide the following documentation on completion of system commissioning: -

1. Certificates for Design, Installation and Commissioning.
2. Operation and Maintenance Manual.
3. “As fitted” drawings.
4. Log Book.
5. Record of agreed variations from the original design specification.
6. BS7671 – Electrical Installation test certificates.

7301022 Logbook

The fire alarm installer shall provide at handover a fire alarm system log book in accordance with Annex F of BS5839-1.