



**Project RED Electrical
Infrastructure.
Manchester.**
Manchester University NHS
Foundation Trust .

MEP SPECIFICATION
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Audit sheet.

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100 PERFORMANCE OBJECTIVES

Supply, install and commission a containerised standby generator power supply for Project RED Electrical infrastructure at Manchester Royal Infirmary to comprise the generator set complete with diesel engine prime mover, alternator, and all control-gear and switchgear.

Provide all auxiliary equipment to including starting systems, air intake and exhaust gas systems, cooling systems, lubricating oil system, fuel system with day storage tank and bulk storage tank, and auxiliary electrical power supply (adequate for all auxiliary electrical loads such as battery charging, engine heaters and anti-condensation heaters).

Design, provide and install all fuel delivery and storage systems.

Ensure that the generating plant provides duty as defined in BS ISO 8528-1 for the following operation:

- ~ Prime rated power capable of and capable of operation at 100% of rated load for 12 consecutive hours and an overload of 10% for one hour.

Ensure that the generating plant monitors mains power and supplies standby power to essential supplies in the event of mains failure. Provide automatic start-up and operation of standby power without manual intervention. Arrange that the standby generator starts on initial demand for standby power and remain running unless shut down as specified herein.

Coordinate closure of standby power to essential supplies bus with LV distribution switchgear provided including:

- ~ Appropriate control settings (eg time delays) and commissioning of the changeover
- ~ Control for the switching of essential switchboards by sequencing and control of LV switchgear

Ensure that the when the generator reaches the specified running speed and output voltage it closes automatically to the switchboard generator busbars.

Use the emergency standby generator's neutral earth connection as the system earth when the supply is from the generator. Break the standby generator neutral earth connections when the generator is connected in parallel with the mains supply. Ensure that all earthing arrangements are in accordance with BS 7430 and The Electricity Safety, Quality and Continuity Regulations.

Do not earth generator neutrals when operating in parallel with HV site network.

Ensure that the essential busbars will be re-energised within a 15 second interval, commencing from the confirmation of loss of mains power.

Arrange for the system to include automatic changeover from standby power back to mains power after a pre-set adjustable period up to ten minutes of stable mains availability. Include for a selectable option that results in restoration of the mains supply to require manual initiation as an alternative. Provide a control system that uses a closed transition return to the mains supply.

Ensure that the control system is configured such that, in the event of a failure of the generator, the power supply will revert to the mains supply with an adjustable delay of up to 15s. This provision is included so that the power supply does not remain off if there is an available supply. If operating in this condition ensure that the generator plant circuit breaker opens and the mains circuit breaker closes.

Arrange for generator plant to continue operating without load for an adjustable period up to 30 minutes after switching from standby power.

Undertake comprehensive final integrated systems tests to prove a complete system prior to handover.

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Testing to be carried out against the load criteria detailed within Appendix A for the normal and abnormal scenarios.

200 DESIGN PARAMETERS

Comply fully with the edition (including amendments, replacement and normative references) of each of the following, current at the time of tender:

The Medium Combustion Plant Directive (MCPD)

Local Authority Environmental Health, Environment Agency and Department for Environment, Food & Rural Affairs requirements and planning conditions

The Clean Air Act

The Control of Pollution (Oil Storage) (England) Regulations

The Electricity Safety, Quality and Continuity Regulations (ESQCR)

The Electricity Supply Regulations

The Electricity at Work Regulations

Environment Protection Act

The Health and Safety at Work etc Act

The Factories Act

The Noise Emission in the Environment by Equipment for Use Outdoors Regulations

HTM 06-01 2017. Health Technical Memorandum Electrical services supply and distribution.

HMIP, D1 Guidelines on discharge stack heights for polluting emissions

ASTM D3306 - 14 Standard Specification for Glycol Base Engine Coolant for Automobile and Light-Duty Service

BS 89-2 Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for ammeters and voltmeters

BS 89-3 Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for wattmeters and varmeters

BS 89-4 Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for frequency meters

BS 89-5 Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for phase meters, power factor meters and synchrosopes

BS 89-7 Direct acting indicating analogue electrical measuring instruments and their accessories. Specification for special requirements for multi-function instruments

BS 159 Specification for high-voltage busbars and busbar connections

BS 799-5 Oil burning equipment. Carbon steel oil storage tanks. Specification

BS 2869 Fuel oils for agricultural, domestic and industrial engines and boilers. Specification

BS 4999-140 General requirements for rotating electrical machines. Specification for voltage regulation and parallel operation of a.c. synchronous generators

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BS 5000-3	Rotating electrical machines of particular types or for particular applications. Generators to be driven by reciprocating internal combustion engines. Requirements for resistance to vibration
BS 5410-3	Code of practice for oil firing. Installations for furnaces, kilns, ovens, oil-fuelled generators and other industrial purposes
BS 5514-6	Reciprocating internal combustion engines. Performance.. Specification for overspeed protection
BS 5854	Code of practice for flues and flue structures in buildings
BS 6472-1	Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting
BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for electrical installations. IET Wiring Regulations. Seventeenth edition
BS 7698-10	Reciprocating internal combustion engine driven alternating current generating sets. Measurement of airborne noise by the enveloping surface method
BS 7698-12	Reciprocating internal combustion engine driven alternating current generating sets. Emergency power supply to safety devices
BS 8233	Guidance on sound insulation and noise reduction for buildings
BS EN 1856-1	Chimneys. Requirements for metal chimneys. System chimney products
BS EN 1856-2	Chimneys. Requirements for metal chimneys. Metal flue liners and connecting flue pipes
BS EN 12285-1	Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the underground storage of flammable and non-flammable water polluting liquids
BS EN 12285-2	Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids
BS EN 60034-1	Rotating electrical machines. Rating and performance
BS EN 60034-5	Rotating electrical machines. Degrees of protection provided by the integral design of rotating electrical machines (IP code). Classification
BS EN 60034-6	Rotating electrical machines. Methods of cooling (IC Code)
BS EN 60034-9	Rotating electrical machines. Noise limits
BS EN 60034-18-1	Rotating electrical machines. Functional evaluation of insulation systems. General guidelines
BS EN 60034-22	Rotating electrical machines. AC generators for reciprocating internal combustion (RIC) engine driven generating sets
BS EN 60076-1	Power transformers. General
BS EN 60076-11	Power transformers. Dry-type transformers
BS EN 60085	Electrical insulation. Thermal evaluation and designation
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 61439-2	Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies
BS EN 61869-2	Instrument transformers. Additional requirements for current transformers

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BS EN 61869-4	Instrument transformers. Additional requirements for combined transformers
BS EN 61869-6	Instrument transformers. Additional general requirements for low-power instrument transformers
BS EN 62271-1	High-voltage switchgear and controlgear. Common specifications
BS EN 62271-200	High-voltage switchgear and controlgear. AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
BS EN ISO 3740	Acoustics. Determination of sound power levels of noise sources. Guidelines for the use of basic standards
BS EN ISO 3744	Acoustics. Determination of sound power levels and sound energy levels of noise sources using sound pressure. Engineering methods for an essentially free field over a reflecting plane.
BS ISO 3046-1	Reciprocating internal combustion engines. Performance. Declarations of power, fuel and lubricating oil consumptions, and test methods. Additional requirements for engines for general use
BS ISO 3046-4	Reciprocating internal combustion engines. Performance. Speed governing
BS ISO 3046-5	Reciprocating internal combustion engines. Performance. Torsional vibrations
BS ISO 6826	Reciprocating internal combustion engines. Fire protection
BS ISO 8528-1	Reciprocating internal combustion engine driven alternating current generating sets. Application, ratings and performance
BS ISO 8528-2	Reciprocating internal combustion engine driven alternating current generating sets. Engines
BS ISO 8528-3	Reciprocating internal combustion engine driven alternating current generating sets. Alternating current generators for generating sets
BS ISO 8528-4	Reciprocating internal combustion engine driven alternating current generating sets. Controlgear and switchgear
BS ISO 8528-5	Reciprocating internal combustion engine driven alternating current generating sets. Generating sets
BS ISO 8528-6	Reciprocating internal combustion engine driven alternating current generating sets. Test methods
BS ISO 8528-7	Reciprocating internal combustion engine driven alternating current generating sets. Technical declarations for specification and design
BS ISO 8528-8	Reciprocating internal combustion engine driven alternating current generating sets. Requirements and tests for low-power generating sets
BS ISO 8528-9	Reciprocating internal combustion engine driven alternating current generating sets. Measurement and evaluation of mechanical vibrations
BS ISO 21940-11	Mechanical vibration. Rotor balancing. Procedures and tolerances for rotors with rigid behaviour
ENA ER G5	Planning levels for harmonic voltage distribution and non-linear equipment for transmission systems and distribution networks in the UK
ENA ER G12	Requirements for the application of protective multiple earthing to low voltage networks
ENA ETR 122	Guide to the application of Engineering Recommendation G5/4 in the assessment of harmonic voltage distortion and connection of non-linear equipment to the electricity supply system in the UK

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210 Generator plant parameters

Ensure that each generator plant delivers the performance parameters listed in Table 1 in full accordance with all other requirements of this Specification. The performance parameters are based on the following ambient environmental site conditions:

~ Barometric pressure:	100 kPa
~ Minimum Air Temperature:	-10°C
~ Maximum Air Temperature:	35°C
~ Relative humidity:	60%

Provide details of all de-rating assumptions and calculations made to achieve performance parameters in Table 1 where these are based on the 'Standard Reference Conditions' of BS ISO 3046-1 for the rated power output of generating sets as set out below:

~ Barometric pressure:	100 kPa
~ Air Ambient Temperature:	25°C
~ Relative humidity:	30%

Comply with the requirements of Table 1 at ambient environmental site conditions defined above.

Table 1

Ref	Generator Set Parameter Description	Value	Units
1	Site standby power demand at 0.8 power factor	1280	kW
2	Rated voltage (at 50 Hz 3 phase supply)	400	V (nominal)
3	BS ISO 8528-1 Performance Class G3	G3	
4	Prime mover rotating speed (nominal speed)	1500	rpm
5	Engine fuel to BS 2869 with low Fatty Acid Methyl Ester (FAME) content suitable for long term storage in excess of 12 months	Class A2	
6	Engine fuel consumption at maximum continuous output	Vendor	l/hr
7	Engine Brake Mean Effective Pressure	Vendor	bar
8	Parallel operation with other generating sets	Yes (future provision)	
9	Exhaust emissions NOx	Vendor	g/kWh
10	Exhaust emissions PM ₁₀	Vendor	g/kWh

220 Alternator parameters

Comply with the requirements of Table 2 at ambient environmental site conditions defined above.

Table 2

Ref	Alternator Parameter Description	Value	Units
1	IP Rating	IP 22	

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2	Alternator type (synchronous/asynchronous)	Synchronous	
3	Alternator duty to BS EN 60034-1	S1	
4	Alternator rated BS EN 60085 thermal insulation class	H (180°C)	
5	Alternator operational continuous rating temperature rise to be limited to BS EN 60085 insulation class.	B (130°C)	
6	Alternator total harmonic distortion to BS EN 60034-1	< 5	%
7	Alternator sub-transient reactance	< 0.15	per unit
8	Alternator enclosure to	IP 22	
9	Alternator mechanical dynamic balance to BS ISO 21940-11	Grade G2.5	
10	Stator winding pitch	2/3	

230 Loading parameters

Provide a fully automatic intelligent generator load management system (LMS) to control the transfer of power from mains to generator source in the event of mains failure, and to control the transfer of power from generator to mains in the event of stable restoration of mains power.

Use Programmable Logic Controllers to control the LMS operation of air circuit breakers (ACBs), generator starting sequencing and interfacing with BMS. Provide open-protocol software, software licences and backup copies of all LMS software.

240 Acoustic and vibration parameters

Provide complete containerised generator set with exhaust silencers for the generating plant capable of limiting the noise external to the generating plant to no more than 85 dBA at 1 metre from the container and exhaust flues.

Ensure the noise level at the closest ward window does shall not exceed the limits set out in HTM 08-01 for patient rooms.

Provide vibration isolation measures to limit vibration transfer from the generator plant to internal areas to not exceed 0.01 m/s² peak acceleration based on Wb weighting as defined in clause 3.3 of BS 6472-1.

300 SYSTEM DESCRIPTION

Provide a complete containerised standby generator installation located as indicated on the drawings consisting of 2No generators each connected to their own dedicated LV switchboard;

- Generator A
- Generator B

Allow sufficient space around the generator plant for maintenance and parts replacements as recommended by the generator manufacturer.

Provide a comprehensive control system to deliver the control functionality described below.

400 CONTROL REQUIREMENTS

410 Overview

Provide the generator with the ability to operate in any one of the following operational modes:

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- ~ Generator test (manual short-term paralleling with HV site network)
- ~ Generator test (manual connection to load bank)
- ~ Automatic standby, including automatic restoration of the mains supply once available

Provide the following level of control software battery backup to all software residing in PLC or other control hardware:

- ~ Dual 24-hour battery backup for critical applications with dual DC power supplies and appropriate blocking diodes. Provide automatic changeover in the event of either battery charging supply failing.

When operating in automatic standby mode start the generator automatically on detection of mains failure. Connect the generator to the switchboard generator terminals once output voltage and frequency is within specified range. Provide the generator's neutral earth connection as the system earth when on standby power.

Arrange for the system to include automatic changeover from standby power back to mains power after a pre-set adjustable period up to ten minutes of stable mains availability. Include for a selectable option that results in restoration of the mains supply to require manual initiation as an alternative. Provide a control system that allows a closed transition return to the mains supply. The closed transition will occur at the Automatic Transfer Switches (ATS) as follows;

- ATS associated with Generator A
 - ATS-EC-A-01
- ATS associated with Generator B
 - ATS-EC-B-01

Ensure that the restoration sequence is configured and interlocked so that only one of the ATS listed above can carry out a closed transition at any time.

Ensure that the control system is configured such that, in the event of a failure of the generator, the power supply will revert to the mains supply with an adjustable delay of up to 15s. This provision is included so that the power supply does not remain off if there is an available supply.

Ensure that the basic transfer of from the mains supply and the generator supply, in the event of a mains failure, is reliant on the minimum amount of equipment and only requires the presence of the generator starting battery and the generator output voltage. Also ensure that the automatic transfer to an available mains supply in the event of a failed generator supply only requires the presence of the mains voltage.

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In the event of extended parallel supply at an Automatic transfer switch (AST), configure that the generator is automatically disconnected from the mains supply and reverts to the automatic standby operation and in the event that there is actually a failure of the mains supply complete the changeover to the generator.

Ensure that if there is a failure of the mains supply when the generator is operating in the Generator test (manual short-term paralleling with HV site network) the system automatically reverts to the automatic standby mode and is available to supply the essential load.

Ensure that if there is a failure of the mains supply when the generator is operating in the Generator test (manual connection to load bank) the system automatically disconnects the loadbank and reverts to the automatic standby mode and is available to supply the essential load.

Provide the generating set with a microprocessor based Local Generator Controller (LGC) to control the following:

- ~ Engine and alternator control systems
- ~ Engine and alternator monitoring, diagnostic and alarm systems
- ~ Alternator electrical protection systems
- ~ Stop, start, emergency stop, manual/automatic controls
- ~ Control of synchronisation equipment
- ~ Control of generator circuit breaker and neutral earthing switch
- ~ Metering

Provide the generator control panel with monitoring and indication of the following day storage tank fuel oil levels and achieve the actions indicated in response to these fuel oil levels:

- ~ Low-low: connect to BMS to raise an alarm that the system is running out of fuel oil and to investigate
- ~ Low: turn on transfer pump and raise indication on BMS
- ~ High: turn off transfer pump
- ~ High-high: send an alarm to the BMS and hard wired signal to turn off the pumps

420 Circuits monitored and controlled

Include full and comprehensive monitoring of each generator and the associated control system as required to give a comprehensive overview of the operation of the generators and the monitoring and logging of alarms.

Monitor the signals for the main circuit and protection circuits and include the information in the status displays for the main substation circuits and Automatic Transfer Switches (ATS) as indicated in the table below. Ensure that the PMS has the ability to control the devices as listed in the table below and that the actions are indicated on displays. Note the detail maybe vendor specific.

Device	Main circuit monitor	Protection monitor	Control required
RMU disconnecter DSS470-RMU-01A-R1	Three position Main circuit on off Circuit earth on		No

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Device	Main circuit monitor	Protection monitor	Control required
RMU disconnect DSS470-RMU-01A-R2	Three position Main circuit on off Circuit earth on		No
RMU Transformer circuit selector DSS470-RMU-A	Two position Main circuit selected Circuit earth selected		No
RMU circuit breaker DSS470-RMU-A	Off On		No
Transformer DSS470-TX-A		Temperature alarm 2 stage (alarm and critical alarm)	No
MSB-470-01-A Incomer circuit breaker	Two state on and off	Tripped Restricted earth fault trip	No
MSB-470-01-A Incomer circuit carriage	Two state engaged isolated		No
MSB-470-01-A Bus connection circuit breaker	Two state on and off		No
MSB-470-01-A Bus connection carriage	Two state engaged isolated	DC battery common alarm for the switchboard Surge suppression alarm	No
MSB-470-G-01-A Incomer circuit breaker	Two state on and off	Tripped Shunt trip operation	No
MSB-470-G-01-A Load bank circuit breaker	Two state on and off	Tripped Shunt trip operation	No
ATS-EC-A-01	Mains or Generator supply		No
RMU disconnect DSS180-RMU-01B-R1	Three position Main circuit on off Circuit earth on		No
RMU disconnect DSS180-RMU-01B-R2	Three position Main circuit on off Circuit earth on		No

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Device	Main circuit monitor	Protection monitor	Control required
RMU Transformer circuit selector DSS180-RMU-B	Two position Main circuit selected Circuit earth selected		No
RMU circuit breaker DSS180-RMU-B	Off On		No
Transformer DSS180-TX-B		Temperature alarm 2 stage (alarm and critical alarm)	No
MSB-180-01-B Incomer circuit breaker	Two state on and off	Tripped Restricted earth fault trip	No
MSB-180-01-B Incomer circuit carriage	Two state engaged isolated		No
MSB-180-01-B Bus connection circuit breaker	Two state on and off		No
MSB-180-01-B Bus connection carriage	Two state engaged isolated	DC battery common alarm for the switchboard Surge suppression alarm	No
MSB-180-G-01-B Incomer circuit breaker	Two state on and off	Tripped Shunt trip operation	No
MSB-180-G-01-B Load bank circuit breaker	Two state on and off	Tripped Shunt trip operation	No
ATS-EC-B-01	Mains or Generator supply		No

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RMU disconnecter DSS240-RMU-R1	Three position Main circuit on off Circuit earth on		No
RMU disconnecter DSS240-RMU-R2	Three position Main circuit on off Circuit earth on		No
RMU Transformer circuit selector DSS240-RMU	Two position Main circuit selected Circuit earth selected		No
RMU circuit breaker DSS240-RMU	Off On		No
Transformer DSS240-TX-CH		Temperature alarm 2 stage (alarm and critical alarm)	No
MSB-240-00-A Incomer circuit breaker	Two state on and off	Tripped Restricted earth fault trip	No
MSB-240-00-A Incomer circuit carriage	Two state engaged isolated		No
MSB-240-00-A Bus connection circuit breaker	Two state on and off		No
MSB-240-00-A Bus connection carriage	Two state engaged isolated	DC battery common alarm for the switchboard Surge suppression alarm	No
MSB-240-G-00-A Incomer circuit breaker	Two state on and off	Tripped Shunt trip operation	No
MSB-240-G-00-A Load bank circuit breaker	Two state on and off	Tripped Shunt trip operation	No

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500 SYSTEM COMPONENTS

510 Electricity generating plant - General

Ensure that the generating plant and all associated current transformers, switchgear, controls and wiring are in all respects mutually compatible and function correctly as a complete system.

Ensure that generators are capable of providing power to the essential supplies within 15 seconds of the failure of the primary supply.

Ensure that the generators and fuel supply system is provided a bulk tank sized 4.2m x 3.0m x 3.0m in height with a total usable fuel capacity of 33,047 litres (minimum) and each generator container is provided with a 1000 litres day tank.

Provide the containerised generator set complete with distribution board, single phase auxiliary power supplies, integral lighting, controls, fire alarm and all necessary auxiliaries to operate the container as a self-contained power supply. Connect the auxiliary power supply to the generator from both the A (MSB-EC-01-A) and B (MSB-EC-01-B) switchboards and include an automatic transfer switch with open transition to connect the auxiliary supplies to an available supply.

520 Engine

521 General

Ensure that each generating set is powered by a four-stroke diesel engine, running at 1500 rpm.

Size the engine to provide the site standby power demand specified in Design Parameters Table 1 whilst delivering the performance class specified in Performance Objectives. Allow for an additional 10% overload capacity for one hour in any twelve hours of running.

Ensure that the engine governor in combination with the total generating set inertia provides for the BS ISO 8528 Performance Class specified in Design Parameters Table 1.

Install an electronic, isochronous, automatic load sharing governor system by Heinzmann, or an equal.

Protect the engine with a Solenoid Quick Release Mechanism (SQRM) and Free Fall Drop Valve by Landon Kingsway, or an equal alternative method and / or supplier to automatically disconnect additional fuel supply in the event of a fire in the generator container.

522 Cooling system

Fit a pressurised closed loop, liquid cooled engine cooling system comprising:

- ~ Unit mounted radiator and engine driven fan
- ~ Thermostatic valve to modulate coolant flow through the radiator to maintain optimum coolant temperature through engine
- ~ Engine driven cooling water circulation pump
- ~ Electrically operated thermostatically controlled immersion heater in the engine cooling circuit to maintain a water temperature of 10°C with an external ambient temperature of minus 10°C
- ~ 50% ethylene glycol and water coolant solution to ASTM D3306 - 14 to prevent corrosion and damage under all normal operating conditions down to -20°C ambient
- ~ A cooling system connection to a suitable drain
- ~ An automatic water make-up system, including a piped water supply in the generator plant room

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523 Engine lubricating system

Provide an efficient lubricating system with an engine driven lubricating oil pump, replaceable filters and oil cooler.

Provide a total usable oil volume which, between normal and minimum levels, is sufficient to enable the engine to run at full load for at least 100 hours unattended, allowing for an oil consumption of 150% of the manufacturer's estimated consumption for a new engine.

Provide a separate electrically driven oil pump to pre-prime the engine lubrication system during the starting sequence, and to circulate oil through the engine from time to time between engine running periods in readiness for an automatic start.

Provide an easily assessable oil level indicator gauge, dipsticks or other suitable means of checking the oil level in the engine.

Provide drain cocks capable of completely draining the engine lubricating oil, and that in any reserve tanks fitted, into a suitable container.

Provide a manual oil drain pump.

524 Starting system

Provide a lead-acid battery operated electric starting system to BS ISO 8528.

Provide dual starter circuits for all generating plant providing critical supplies

Provide only long-life heavy duty batteries.

Ensure that batteries have sufficient ampere-hour capacity at an ambient temperature of 10°C to provide three starts of ten seconds duration each with five seconds break between them as per BS 7698-12. Allow for reset of any generator set lock-out after three successive cranks.

Ensure that all battery powered monitoring or control circuits continue to operate under cranking.

Provide controlled charging of the batteries from the main electrical system. Ensure that the charger recharges in constant current mode then switches to constant voltage for float charge at end of charging period. Provide for chargers to be capable of recharging a flat battery within five hours.

Ensure that batteries and charging systems are adequately ventilated and secured in protective steel enclosures.

Provide indications of battery and charger status to include:

- ~ Voltage / charge state
- ~ Faults

525 Engine exhaust

Install an engine exhaust system to comply with the Environment Agency's requirements and which takes the engine exhaust gases clear of the building and all ventilation air intakes.

The exhaust system flue height allowance to be 14m, agreement on final height required.

Include the following features:

- ~ Install the exhaust system via the most direct practicable route, with minimum length and bends. Protect the exhaust system from rain and snow ingress.
- ~ Make the exhaust system of a suitable grade of stainless steel, including necessary flanged sleeved bellows pieces and flexible sections to take up expansion and vibration.

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- ~ Suitably insulate the exhaust system to reduce heat released into the container and to protect personnel from accidental contact with hot surfaces.
- ~ Fit industrial exhaust silencers close to the engine to provide noise attenuation to meet the requirements of this Specification.

Ensure that the flue is capable of withstanding the operating pressure and temperatures specified by the engine manufacturer. Ensure that the flue pressure drop is suitable for the full engine operating range.

Support the silencer(s) and exhaust system with adequate hangers and brackets. Protect the flue from contact with any flammable materials. Provide an efficient weathering cravat where the flue passes through any roof or external wall. Suitably terminate the flue to minimise the risk of water ingress, or blockage by birds or other foreign matter.

Provide adequate condensate traps with drains made from stainless steel or other suitable metal and connect with suitable terminations to the site drains. Install exhaust system components so that condensate is reliably collected and prevented from running back into the engine.

530 Fuel system

Provide an engine fuel storage system and fuel train which overall complies with the requirements of the local Fire and Building Control Officers.

Provide all fuel oil required for testing and commissioning. Ensure both day storage tank and bulk storage tanks are replenished following testing and commissioning to leave the tanks full at practical completion.

Ensure all generator fuel oil complies with the engine manufacturer's fuel specification and is in accordance with BS 2869. Ensure all fuel oil stored in tank(s) have properties suitable for long storage life.

Install a fuel transfer system to transfer fuel from the bulk storage fuel tank to each generator day tank. Include duplex pumps adjacent to the bulk storage tanks for the transfer of fuel to the generator day tank. Provide a power supply to the transfer pumps from the generator such that the pump supply only relies on the availability of the generator output. Use a twin wall (pipe in pipe) fuel pipework system for the fuel line from the bulk storage tank to the generator. Include leak detection in the fuel transfer pipework.

Use the level control for the day tank to control the fuel transfer system. Provide two separate low level sensors for the day tank. Start the duty pump and open the fill solenoid valve when fuel is at the low level point in the day tank. Start the standby pump and raise an alarm when the fuel in the day tank is at the low-low level in the day tank.

Include a lockable manual bypass hand valve to allow manual intervention for filling of the day tank from an external fill point from a road tanker and by means of a barrel pump and barrels. Provide one semi rotary barrel pump and for the installation.

Include two separate high level sensors for the day tank. Stop the pump and close the fill solenoid valve when fuel is at the high level point in the day tank. Raise an alarm when the fuel in the day tank is at the high-high level in the day tank..

Include a site glass or other calibrated direct acting level gauge for each day tank.

Ensure the day tank is provided double skinned / self banded. Include leak detection in the bund to raise the alarm for any leakage. Ensure all fuel pipework in the generator container is effectively fire protected. Include shutoff valves to prevent leakage of fuel into the container in the event of a fire.

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Include provisions for draining the fuel tank and bund. Provide a means by which the day tank can be filled from a road tanker and by means of a barrel pump and barrels. Provide one semi rotary barrel pump and one electric barrel pump for the installation.

Supply, install and commission fuel oil leakage detection system to monitor:

- ~ The bulk storage tank bund
- ~ The day storage tank bund

Ensure that fuel oil leakage detection system fails safe to hold off fuel transfer pumps.

Arrange all fuel oil leak detection systems to provide visible and audible alarms annunciations both at the location of the detected leak and relayed remotely to the building BMS.

Extend vents to the outside of the containers and positioned away from all building openings and air intakes.

Make all pipework from mild steel. Paint with one coat of primer and two coats of approved aluminium paint.

540 Alternator

Ensure that the alternator is suitable for 400/230 V, 50 Hz, 3-phase operation.

Provide a brushless synchronous two-bearing alternator directly driven by the engine and rated to match the nominal engine speed. Ensure that the alternator is designed and constructed to meet the appropriate sections of BS 4999, BS EN 60034, BS ISO 8528-3 and BS 5000-3. Incorporate the following features:

- ~ Capability of withstanding an engine over-speed of plus 20%
- ~ Nominal voltage output plus or minus 6%
- ~ Output voltage waveform irregularities at maximum continuous rating conforming to BS EN 60034-1
- ~ Separate excitation by permanent magnet generator and integral exciter

Fit the alternator with a thermostatically controlled anti-condensation heater in all outdoor applications.

Fit the alternator with an air filter in all outdoor applications where dust concentrations in cooling air could be abrasive to the alternator windings.

550 Automatic voltage regulator

Install a microprocessor controlled automatic voltage regulator incorporating the following features:

- ~ Three-phase RMS output voltage sensing
- ~ Minimum voltage waveform disturbance when supplying non-linear loads
- ~ Voltage regulation within plus or minus 0.5 %
- ~ Protection against sustained over excitation caused by internal or external faults
- ~ Adjustable protection against over-voltage
- ~ Adjustable short circuit current limitation
- ~ Environmental protection to IP54

560 Noise and vibration control

Provide a full acoustic test report to recognised international standards in octave-based resolution. Perform and supply detailed acoustic calculations to include structural and airborne noise at both

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plant start-up and steady running condition. Issue the report to the Contact Administrator for comment prior to procurement of plant.

Perform all remedial acoustics works necessary to meet specifications at no additional cost and without impact to programme. Allow for any acoustic treatment (such as framing and 100 mm of acoustic insulation) of the structure surrounding open generating plant and coordinate via the Contractor Administrator with architect as necessary.

Ensure that the generator installation (in situ) does not exceed the acoustic design limits specified. Measure and report to the Contract Administrator the noise levels experienced during normal operation.

Provide air intake and air discharge attenuators with weatherproof acoustic louvres and fire dampers.

Comply with the requirements of section Y45 of this Specification.

600 EQUIPMENT

Ensure all generator LV switchgear and control gear assemblies have verification to BS EN 61439.

Ensure that the assembly maintains BS EN 61439 verification after integration into the on-site electrical systems.

Ensure all individual devices and self-contained components within assemblies comply with relevant product standards.

610 Generator control panel

Ensure that the control panel is isolated from generating set vibration.

Arrange the enclosure with lockable front access doors, protected to IP54, and finished and painted in the manufacturer's standard colour. Provide mechanical extract ventilation with a filtered air inlet. Provide a prominent notice to warn of the danger of opening the panel door without isolating supplies.

Include the main output circuit breaker, load bank circuit breaker, connections for the external main switchboards and the neutral earth switch as indicated on the drawings.

Shroud power connections against accidental contact when live. Contain all minor wiring in slotted ducting. Terminate small wiring in shrouded terminal strips numbered as in the contract drawings.

Incorporate all necessary controls to deliver the Performance Objectives, Control Requirements and Design Parameters specified herein.

Ensure that the controller is equipped with an easily readable backlit intelligent LCD Human Machine Interface (HMI) graphical display and clear visual and audible alarm indicators.

Ensure that the HMI provides a backlit auto dimming LCD minimum 9" colour display with resistive / capacitive touch screen technology and configurable audible sounder. Ensure that the HMI display has a low level of display latency (ie display responses quickly without appreciable time lag).

Arrange that the generator controller provides the functionality detailed below:

Provide the following engine control and monitoring:

- ~ Start preheating and/or pre-lubrication
- ~ Start / stop sequencing with selectable start attempts
- ~ Speed control and monitoring
- ~ Stop sequencing and cool down

Provide the following generator monitoring and control:

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- ~ Voltage, current, frequency, power, power factor, reactive power; each with ability to display all phases concurrently
- ~ Over-voltage, under-voltage protection
- ~ Over-frequency, under-frequency protection
- ~ Overcurrent and overload protection
- ~ Phase sequence and reverse power protection
- ~ Mains monitoring for voltage and frequency
- ~ Event log with each event date and time tagged

Provide the generator controller with MODBUS / Internet protocol (IP) / Global System for Mobile communication (GSM) communication functionality.

Provide the following generator control panel mounted meters each at least 100 mm square:

- ~ Frequency indicator scaled 45 Hz to 55 Hz
- ~ Voltmeter, scaled to nominal output volts plus 10%
- ~ Ammeter, scaled to full load plus 15%

Provide the following generator control panel mounted controls and indicators:

- ~ Voltmeter selector switch, phase to phase, phase to neutral, and Off
- ~ Ammeter selector switch, each phase and Off
- ~ Engine run hours (without reset)
- ~ Auto / Manual / Off / Reset selector switch
- ~ Engine start push button (operative in 'Manual' control only)
- ~ Engine stop push button (cancelled by Reset)
- ~ Generator start initiated indicator lamp
- ~ Generator start fail indicator lamp
- ~ Battery charger fault indicator lamp
- ~ Battery volts low indicator lamp
- ~ Over-speed alarm indicator lamp
- ~ Low oil pressure alarm indicator lamp
- ~ Low coolant pressure / level alarm
- ~ Engine low fuel alarm
- ~ High temperature alarm
- ~ Preheater ON indicator
- ~ Fuel leak detection alarm

620 Generating set monitoring

Provide relays with volt free contacts wired to a terminal block for connection to the BMS via external wiring to indicate the following conditions:

- ~ Generator connected to the LV switchboard; one relay for each generator

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- ~ Generator tripped; one relay for each generator
- ~ Generator common alarm; link all alarm signals to the common alarm relay

630 Ventilation and cooling

Ensure that the generating plant ventilation system, including air intakes and air outlets, will provide enough outside fresh air for combustion and cooling, and that no recirculation of ventilating air is possible between air intakes and air outlets. Ensure all parts of the generating plant and associated equipment operate within allowable thermal operating limits whilst operating at 110% of its maximum continuous rating, with the building complete and operational, and at maximum specified outside ambient conditions.

Protect the generating plant against frost with the specified minimum ambient air temperatures.

Protect the generating plant from the ingress of rain, snow and hail, and of birds and small mammals.

Fit gravity dampers to ventilation air outlets and motorised dampers to air inlets.

Allow for the ventilation air inlets to remain open for a period of up to 30 minutes (adjustable) after the generator has shut down. This will allow for any residual heat build-up to be removed.

700 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with section Y82 of this Specification.

Where site generating plant can be interconnected with the incoming main electricity supply, provide the information required by The Electricity Safety, Quality and Continuity Regulations.

800 TESTING AND COMMISSIONING

Comply with the requirements of sections Y51 and Y81 of this Specification.

Supply, install and set up all necessary test materials and equipment eg resistive and reactive load banks, fuel, oil, and measuring equipment as necessary for undertaking testing and commissioning. Provide all necessary personnel for the duration of tests. Remove all test materials and equipment on successful completion of testing and commissioning and make good any alterations made.

Allow for all rectification of all faults during testing. Repeat testing, either wholly or in part, after rectification of any faults occurring during testing which necessitates the repair or replacement of important parts or functions of the generating set. Repeat testing as required to achieve acceptance by the Contract Administrator.

Record all measured parameters in time tagged format and provide any such analysis and interpretation as necessary to explain the findings. Include these measurements and interpretation in all test reports specified below.

810 Works tests prior to despatch

Perform a factory test as per BS ISO 8528-6 Functional Test to demonstrate compliance with all aspects of this Specification. Perform tests for the generator within the container as a complete installation at the rated loads and for the durations given below. Measure fuel and lubricating oil consumption at full load.

- ~ Load to 25% for 10 minutes and prove stable
- ~ Load to 50% for 10 minutes and prove stable
- ~ Load to 75% for 10 minutes and prove stable
- ~ Load to 100% for 4 hours

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~ Load to 110% for 1 hour

Prove that the generator is within the limits required to meet the specified Performance Class given in Table 2 above.

Allow for witnessing by the client's representative and give two-weeks' notice of the date of the works tests. Provide the functional test report within 7 days of test completion.

820 Commissioning following installation

Verify that the complete generating set is installed as designed and specified, including all wiring connections.

Verify proper installation and fixing on site including all noise attenuation and vibration attenuation measures. Check the integrity of all site connections including wiring, power connections, busbar connections and each element of the engine-alternator system. Check for air, exhaust and fluid leaks.

Test the power and control wiring installation, including the earthing system.

Check the functioning of all switchgear, interlocks and controls.

Check the functioning of all auxiliary equipment. Set fuel pump overloads, measure running currents and fuel flow rates.

Calibrate all sensors and relays in co-operation with others where appropriate.

Provide the first fill of fuel oil, lubricating oil and anti-freeze.

Configure all generator controls, input, outputs and variable settings to optimally deliver the Performance Objectives and Design Parameters specified herein.

Commission, test and demonstrate the complete fuel system.

830 Site acceptance tests and demonstrations

Perform a site acceptance test after commissioning as per BS ISO 8528-6 Acceptance Test to demonstrate compliance with all aspects of this Specification. Allow for all fuel oil consumed during test and replenish after testing.

Verify that exhaust system back pressure is within the engine manufacturer's specified limits at full rated load.

Ensure that the starter batteries electrolyte levels are full and to the correct specific gravity. Ensure the correct functioning of the battery charging system.

With the generators running off load, demonstrate automatic starting on loss of mains, manual and automatic synchronising, and automatic operation of the earthing system.

With a load bank connected demonstrate that the generators will deliver their full load output for 4 hours followed immediately by 1 hour at 110% of full load. Confirm that the ventilation system provides all required combustion and cooling airflow. Measure and record the generator temperature rises and confirm that these are within the manufacturers operating limits.

Measure noise levels at 1 m and at 10 m from all external louvres and from the exhaust system with the generators at 110% of full load to prove acoustic performance of exhaust and attenuators systems.

Undertake comprehensive testing of the changeover functionality at each of the steps in the project where there is a change to the generator connection.

Undertake comprehensive final integrated systems tests to prove a complete system prior to handover.

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Testing to be carried out against the load criteria detailed within Appendix A for the normal and abnormal scenarios.

Confirm and test all fuel oil systems to include all pumps, controlgear and switchgear. Ensure that the leak detector system performs as intended and correctly interfaces to the BMS / Facilities Management / Security Teams.

Ensure that the generator does not display any signs of overheating during all site tests as a result of load current harmonics or excessive reactive power flow.

Provide the acceptance test report within 7 days of test completion.

840 Operator training

Provide generator set training including individual trainee training / operators documentation.

850 Handover

Ensure that the following are completed at handover:

- ~ Any documented snagging is complete or an agreed date for clearance is determined
- ~ Complete sets of operating and maintenance instructions are left with system, any agreed amendments/additions required are documented and a target date for completion is agreed
- ~ Training of engineers and operators is complete or a program for completion is agreed
- ~ All logs and commissioning documents are complete

900 SCHEDULE OF INSTALLER'S SUBMITTALS

Comply with section A30 of this specification.

Submit the following in a timely manner in accordance with the program.

- the full specification of the generator and all auxiliary plant and equipment to be supplied,
- generator sizing calculation and full data sheet with electrical parameters and inertia data.
- net electrical output power at the engine design reference conditions and under the specified service conditions
- the specification of the fuel used and fuel consumption at maximum continuous output
- the specification of the lubricating oil to be used and lubricating oil consumption at maximum continuous output
- exhaust emissions
- brake mean effective pressure
- detailed general arrangement drawings of all plant and equipment

910 Pre-acceptance testing

Two weeks before the works acceptance tests are scheduled, submit a method statement for the following tests and demonstrations:

- ~ Works functional tests
- ~ Site installation inspection
- ~ Pre-running functional checks of the complete generator system, including checks and calibration of all load sensing instruments and interlocks by others

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- ~ Load bank testing, including a demonstration of synchronising paralleling and load sharing
- ~ Mains failure tests
- ~ Instruction of the owner's personnel in the operation of the complete generating plant

920 Pre-handover

Four weeks before handing over the completed installation submit the following documents to the Contract Administrator for comment:

- ~ Makers' works test certificates
- ~ Site commissioning and load test certificates
- ~ Acoustic test reports
- ~ Record drawings
- ~ Operating and maintenance instructions

930 Operating and maintenance instructions

Supply two copies of the Operating and maintenance instructions.

Include all necessary operating instructions, warnings and advice with regard to the engine, generator, controls, switchgear and all ancillary equipment.

Provide the following details:

- ~ Generating set description and specification
- ~ Operating instructions
- ~ Component data sheets
- ~ Commissioning method statement
- ~ Maintenance instructions
- ~ Fault finding guidance
- ~ Circuit diagrams and general arrangement drawings
- ~ Spares ordering information
- ~ Personnel and equipment safety warnings

END OF SECTION V10

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V11 HV ELECTRICITY SUPPLY

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100 PERFORMANCE OBJECTIVES

The HV distribution network is defined as being from the point of each DNO incoming HV delivery (intake substation) located at site through to the first downstream LV switchboard after each HV/LV transformer. The HV distribution system for the site exists and the works described in the specification and on the drawings are to amend the existing HV rings as follows;

- HV Ring 1 to add Substation DSS180 (Substation B) and decommission existing Welcome Building DSS 110 substation.
- HV Ring 2 to add Substation DSS240 (Chiller Substation) and decommission existing Phase 1 Chillers DSS 230 substation.
- HV Ring 4 to add Substation DSS470 (Substation A).

The project requires but is not limited to the rerouting of existing HV cable routes in the area associated with the project, the provision of new ring main units to the substation transformers, the, the provision of standby generation plant, new main LV switchgear, reconnection of existing distribution circuits and all associated works as indicated on the drawings and in the specification.

The area of the site for the project is which is adjacent to the existing Welcome Building and adjacent to the existing MRI building associated with the accident and emergency department.

The objective of the project is to provide the new substations and decommission existing substations whilst minimising the disruption to the operation of the hospital whilst the works are in progress. The drawings provide a step by step sequence of the main elements of the replacement works, the steps are intended to indicate the expected sequence of the changeover and the scale of the works required at each step, not every aspect of every step is included in detail. Plan the changeover steps in detail with the hospital engineers who will require operational control of the system at all times to facilitate the safe operation of the hospital. Minimise equipment and circuit outages (periods when the equipment of circuit is out of service). In general for the changeover of LV circuits only single circuit outages will be allowed at any time. Outages of plant items and circuit outages that require hospital functions to be out of service will normally be required to be undertaken outside the normal working hours of the facility. Any Outages will need to be agreed in advance and a permit agreed as required.

Provide for the supply, installation, testing and commissioning, energisation and all other works as may be needed to realise the complete HV system in accordance with the requirements of this specification and drawings.

Provide HV switchgear as detailed on the drawing(s) and within this specification in the form of a Ring Main Unit (RMU).

Provide an HV distribution network suitable for connection via HV/LV transformer(s) to a 400/230V 3-wire plus separate earth and protective conductors (TN-S) site distribution system to BS 7671.

Provide all the auxiliary controls, electrical protection devices, mechanical and electrical interlocks, DC auxiliary supplies and metering as detailed on the drawing(s) and within this specification.

Provide safe and reliable means of connection, disconnection or reconfiguration of 6.6 kV circuits, both under normal and abnormal (fault) conditions.

Provide only equipment and components not foreseeably identified for withdrawal from either manufacture or continuing manufacturer support with a view to maintaining a supported operational life of fifteen years. Do not use any equipment or components identified as end of line or otherwise not expected to have manufacturer continuing support and spares availability.

The Trust preferred manufacturer of RMU's is Schneider and the transformers is Wilson Power Distribution.

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200 DESIGN PARAMETERS

210 Reference documents

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Factories Act

The Health and Safety at Work etc. Act

The Electricity Safety, Quality and Continuity Regulations

The Electricity at Work Regulations

Memorandum of Guidance on the Electricity at Work Regulations

EU Regulation	No 548/2014 implementing Ecodesign Directive 2009/125/EC with regard to small, medium and large power transformers
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BS 89	Direct acting indicating analogue electrical measuring instruments and their accessories
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BS 2562	Specification for cable boxes for transformers and reactors
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BS 2692-2	Fuses for voltages exceeding 1000 V. AC Expulsion fuses.
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BS 6626	Maintenance of electrical switchgear and controlgear for voltages above 1 kV and up to and including 36 kV. Code of practice
---------	--

BS 7197	Specification for performance of bonds for electric power cable terminations and joints for system voltages up to 36 kV
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BS 7430	Code of practice for protective earthing of electrical installations
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BS 7671	Requirements for electrical installations. IET Wiring Regulations
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BS EN 13190	Dial thermometers
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BS 2562	Specification for cable boxes for transformers and reactors
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BS EN 50160	Voltage characteristics of electricity supplied by public distribution networks
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BS EN 50216-11	Power transformers and reactor fittings. Oil and winding temperature indicators
----------------	---

BS EN 50464	Three-phase oil-immersed distribution transformers 50 Hz, from 50 kVA to 2500 kVA with highest voltage for equipment not exceeding 36 kV
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BS EN 50522	Earthing of power installations exceeding 1 kV AC
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BS EN 50588-1	Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV. General requirements
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BS EN 60044-3	Instrument transformers. Combined transformers
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BS EN 60044-7	Instrument transformers. Electronic voltage transformers
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BS EN 60044-8	Instrument transformers. Electronic current transformers
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BS EN 60051-1	Direct acting indicating analogue electrical measuring instruments and their accessories. Definitions and general requirements common to all parts
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BS EN IEC 60076	Power transformers. Dry-type transformers
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BS EN 60085	Electrical insulation. Thermal evaluation and designation
BS EN 60255	Measuring relays and protection equipment
BS EN 60269	Low-voltage fuses
BS EN 60282	High-voltage fuses. Current limiting fuses
BS EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals and conductors
BS EN 60480	Guidelines for the checking and treatment of sulphur hexafluoride (SF ₆) taken from electrical equipment and specification for its re-use
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)
BS EN 60871	Shunt capacitors for AC. power systems having a rated voltage above 1000 V
BS EN 61111	Live working. Electrical insulating matting
BS EN 61439	Low voltage switchgear and controlgear assemblies
BS EN 61508	Functional safety of electrical/electronic/ programmable electronic safety-related systems
BS EN 61869	Instrument transformers
BS EN 61936-1	Power installations exceeding 1 kV AC. Common rules
BS EN 62053-11	Electricity metering equipment (AC.). Particular requirements Part 11: Electromechanical meters for active energy (classes 0.5, 1 and 2)
BS EN 62208	Empty enclosures for low-voltage switchgear and controlgear assemblies. General requirements
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against mechanical impacts (IK code)
BS EN 62271	High-voltage switchgear and controlgear
ENA ER G5/4-1	Planning levels for harmonic voltage distortion and connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom
EN ER G99	Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019.
ENA TS 41-36	Switchgear for service up to 36 kV (cable and overhead conductor connected)
ENA TS 41-24	Guidelines for the design, installation, testing and maintenance of main earthing systems in substations
ENA ER S34	A guide for assessing the rise of earth potential at substation sites

220 Electricity supply characteristics

Provide the HV distribution network with due regard to the relevant supply characteristics as agreed with the DNO as follows:

~ 6.6 kV supply voltage/frequency	:[6.6 kV 50 Hz]
~ metering position	:[Existing intake substation]
~ prospective 6.6 kV short circuit current	:[tbc by Electrical North West]

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230 Protection co-ordination/Selectivity study

Ensure that the system is supplied, installed and commissioned in accordance with the protection co-ordination study, provided by Electricity North West.

Ensure that full Selectivity is achieved using devices supplied by the manufacturer and demonstrate this prior to installation.

Issue a record of all protection device settings to the Contract Administrator prior to commissioning. On completion of the testing and commissioning, confirm that the devices have been setup in accordance with the settings issued to the Contract Administrator. Any changes must be motivated with the supporting calculations.

240 Switchroom over-pressure calculations

Undertake calculations and verify that in the event of a switchboard internal fault the over-pressure generated within the switchroom is adequately relieved by the vents provided, such that the physical integrity of the room is maintained.

Include full details of the calculation in the Health and Safety file.

250 Definitions

Apply and use the following definition for switch states:

- ~ ON – switch is closed with negligible resistance to current flow
- ~ OFF – switch is open with open-circuit resistance and no current flow

Do not use the terms “Open” or “Closed” with reference to switch states.

300 SYSTEM DESCRIPTION

The HV distribution network is indicated on the schematic drawings to show the required HV switchgear and the location of electrical equipment, protection, interlocking and metering.

Provide the HV system to include the following equipment, systems and any other ancillary equipment as necessary to ensure full functionality in accordance with this specification:

400 CONTROL REQUIREMENTS

410 Interlocking facilities

The RMU's / transformer do not require any dedicated interlocking facilities; all switching operations will be controlled via padlocks, under a Permit to Access and Permit to Work system.

420 Remote switching and power management system (PMS)

Interface switchgear with the Power Management System (PMS) as described in section V10 of this Specification, for control and indications.

430 Protection requirements

431 Transformer protection

Provide the RMU circuit breaker with a self-powered IDMT overcurrent and earth fault relay complying with BS EN 60255. Ensure that the protection relay operates the circuit breaker as required by the protection co-ordination study as detailed by Electricity North West.

Provide a manual breaker trip lever.

432 Restricted earth fault protection

Provide protection relay(s) to trip the HV switchgear and to disconnect the HV/LV transformer(s) in the event of an earth fault in the transformer LV windings or in the LV cables between the transformer and the LV switchboard. Relays to be MICOM IDMT overcurrent (OC) and earth fault (EF).

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433 Auxiliary power supply

No Auxiliary power supply is required on the basis the RMU have self-powered protection.

434 Pilot wire

No requirements. The existing HV Ring operation with open HV ring.

435 LV air circuit breaker controls

Comply with section V20 of this Specification.

436 Emergency power off (EPO) requirements

Mount Emergency Power Off (EPO) push buttons internally within each HV switchroom adjacent to all plant room personnel access doors. Arrange each EPO push button to disconnect all HV supplies to its associated room (which will include the disconnection of all HV feeders to that room). Use EPO push buttons that have purpose-made transparent covers to avoid accidental operation of the switch and ensure that the cover has sealed breakable tags that are stamped or labelled, and key operated reset switches. Ensure that the HV switchgear manufacturer provides sufficient control contacts to permit the installation of all EPO push buttons.

The requirement for the provision of EPO to be agreed with Estates.

500 SCOPE OF WORKS

The scope of works for the HV electrical supply system is as shown on the drawings, schedules, V11 system specification, and other documentation used to describe the HV electrical supply system. Perform and deliver the scope of works to conform to the relevant A Sections.

600 SYSTEM COMPONENTS

610 HV switchgear - General

611 Construction and rating

Select switchgear and controlgear for normal service conditions as defined in BS EN 62271 selecting the conditions for indoor switchgear and controlgear as appropriate for the location. Rate all switchgear components for the electrical system characteristics as follows:

Rated Voltage (U_r)	12 kV 3 phase 50 Hz
Rated insulation level	75 kV
Rated nominal current for busbars (I_r)	630 A
Rated nominal current for circuit breakers (I_r)	630 A
Rated nominal current for switches (I_r)	630 A
Rated short time withstand current (3 sec) (I_k)	20 kA
Rated short-time phase to earth withstand current (3 Sec) (I_{ke})	20 kA
Rated peak withstand current (I_p)	40 kA
Rated duration of short circuit current (t_k)	1 s
Enclosure degree of protection	IP3XD as a minimum

Select indoor switchgear and control gear with an Internal Arc Classification (IAC) (BS EN 62271-200 Annex A) of AFLR at the above values of I_k and t_k as a minimum.

Indoor equipment ambient air temperature does not exceed 40°C and its average value, measured over a period of 24 h, does not exceed 35°C. The minimum ambient air temperature is -5°C (class minus 5 indoor).

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V11 HV ELECTRICITY SUPPLY

Provide all equipment to form a complete operating installation, including fixed and moveable / withdrawable items as appropriate. Provide busbars and connections manufactured from hard drawn copper.

Provide cable boxes, gland plates, glands and terminals suitable for the type, size and number of cables to be terminated. Make provision, adjacent to the cable termination, for connecting earthing cable armouring to the earth busbar.

Provide all necessary loose equipment required for the operation and maintenance of the high voltage switchgear, including circuit breakers handling equipment, lifting tackle, tools, operating handles as appropriate. Provide lockers or wall racks for the storage of these loose items.

Provide switchgear mounted manual tripping facilities acting directly on the circuit breaker mechanism.

620 HV switchgear ring main units (RMU)

Provide all equipment to form a complete operating Ring Main Unit (RMU). Comply with the requirements in clause 610 above.

Provide hand-operated, fixed type, non-extensible, indoor ring main unit, with vacuum circuit breaker, protected to IP32, as shown on the drawings, with ratings as detailed in clause 610 above.

Provide the RMU circuit breaker with a self-powered IDMT overcurrent and earth fault relay complying with BS EN 60255. Ensure that the protection relay operates the circuit breaker as required by the protection co-ordination study as detailed by Electricity North West.

Provide cable connection facilities as shown on the drawings.

Provide facilities for testing of the associated circuit. Ensure that interlocks are fitted to allow access for testing with the associated circuit in the earthed position. Ensure that after insertion of the test probe the switch can be placed in the 'OFF' position. Fit interlocks to ensure that the switch cannot be placed in the 'ON' position with the test facility in use.

Provide a manual circuit breaker trip lever/push button.

Provide a mechanical operation indicator showing whether the breaker is ON or OFF, add the following indication a part of the Power management system as detailed in V10 clause 420.

Provide a manual breaker trip lever.

Provide each of the RMU Ring disconnectors and the RMU circuit breaker with voltage presence induction system (VPIS) and earth fault passages indicators (EFI).

Relays to be MICOM IDMT overcurrent (OC) and earth fault (EF).

Test access required on vacuum circuit breaker (VCB) circuit.

630 HV/LV transformers

631 Ecodesign requirements

Ensure all transformers comply with EU Regulation No 548/2014 for small, medium and large power transformers.

Ensure that all transformers comply with the Tier 2 requirements of EU Regulation No 548/2014 as applicable at the time of purchase.

Provide all technical documentation required by EU Regulation No 548/2014.

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V11 HV ELECTRICITY SUPPLY

Provide all transformers with a rating plate affixed in an accessible position to clearly and legibly show the following in accordance with EU Regulation No 548/2014:

- ~ rated power
- ~ load and no-load loss or peak efficiency index
- ~ electrical power for cooling at no-load
- ~ weight of main components of transformer

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V11 HV ELECTRICITY SUPPLY

632 Liquid-cooled HV/LV transformers

Provide liquid-cooled 3-phase HV/LV transformer to BS EN 60076 and BS EN 50464 as shown on the drawings and as follows for each of:

- HV Ring 1 to add Substation DSS180 (Substation B)
- HV Ring 2 to add Substation DSS240 (Chiller Substation)
- HV Ring 4 to add Substation DSS470 (Substation A).

Midel fluid filled, hermetically sealed HV/LV transformer for internal mounting to the following specification:

Table – Liquid-cooled HV/LV transformer specification		
Nominal voltage	400 V	6.6 kV
System highest voltage	1 kV	tbc by Electrical North West
Lightning impulse withstand voltage (peak)	28 kV	75 kV
One-minute power frequency withstand voltage	28 kV	28 kV
Open-terminal voltage	420 V	
Transformer rating	1600 kVA	
System frequency	50Hz	
K factor (%)	1 %	
Core material	Amorphous Metal	
Winding material	Copper / Aluminium.	
Number of phases	three phase	
System fault current / level	80kA	tbc by Electrical North West
Cooling method (to BS EN 60076-2)	KNAN cooling	
Vector group (to BS EN 60076-1)	Dyn11 group	
Off-load HV voltage tapplings of:	±5%, ±2.5% & 0%	
Winding insulation (to BS EN 60085)	Class 105°C (A)	
Transformer-mounted switchgear or cable boxes	HV bottom entry cable box / LV bottom entry cable box	

Provide connection diagram, lifting lugs, casing earth terminal, liquid level indicator, drain valve and thermometer pocket.

Provide breathers as standard to each transformer.

Provide transformer liquid temperature monitoring unit consisting of a self-contained, Class 1: BS EN 13190: accuracy indication conforming to BS EN 50216-11. Mount the unit on the transformer

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V11 HV ELECTRICITY SUPPLY

housing, adjacent to the rotary off-load tap changer (if possible) to ensure good access to the body of the oil temperature monitor. Select a unit with the following features:

- ~ Liquid temperature indicator or winding temperature indicator (WTI)
- ~ Fully temperature compensated
- ~ Three auxiliary contacts, 5A rated with selectable normally open or normally closed contacts
- ~ Ingress protected to IP55
- ~ Maximum temperature pointer (to record maximum oil temperature)
- ~ Laminated safety glass window with UV protection

Use the output contacts as detailed in the control section above, as shown on the drawings or if not specifically detailed as follows:

Provide transformer temperature alarm 2 stage;

- ~ Contact 1 alarm (provide connection to the building BMS)
- ~ Contact 2 critical alarm (provide connection to the building BMS)
- ~ Contact 3 spare

700 EQUIPMENT

710 Switchgear and protection auxiliary power supply

Provide all auxiliary supplies required (control, protective devices, indication, heaters, etc).

Ensure supply circuit breaker closing (including spring charging), tripping, control and indication is powered from suitably rated DC supply units. Supply one complete tripling battery/charger set for each switch panel. Size the unit to provide a standby period of at least 48 hours at the end of the design battery life, and allowing the facility for the following sequence for all connected switching devices at the end of the standby power period:

- ~ switch off
- ~ switch on switch off
- ~ switch on switch off
- ~ switch on switch off
- ~ switch on

Fuse/protect all auxiliary supplies within each circuit breaker housing individually.

Provide nickel cadmium batteries with associated battery chargers in a steel enclosure remote from the switchboard. Provide control facilities including the following:

- ~ mains power supply and isolating switch
- ~ indication lights: red for charging and green for a fully charged state
- ~ fault relay with volt-free contacts to alarm the BMS system if the auxiliary power supply fails

Provide outgoing circuits that allow two adjacent switchboards to be supplied from a single battery/charger supply to facilitate maintenance or repair of DC supply equipment. Provide details of the autonomy period achieved whilst supplying the full load of both switchboards.

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V11 HV ELECTRICITY SUPPLY

720 Operational safety items

Supply a sufficient number of robust brass (or other approved material) padlocks to cater for the maximum simultaneous permutation of lockable items. Paint padlocks on earthing mechanisms red and ensure they have different key numbers. Provide two keys for each padlock, each key having a permanent label.

Provide padlocks for the following items plus any others specified elsewhere in this Specification:

- ~ to lock circuit breakers in the service or earth position
- ~ to lock shutters closed
- ~ to lock voltage transformers in position
- ~ to lock local/ remote selectors

Supply and install a purpose-made wall-mounted key cabinet with a lockable glass front door in every HV switchroom to accommodate all of the associated padlock keys. Ensure that every key hook is labelled with the appropriate key reference.

730 Earthing system

Comply with section Y80 of this Specification.

Provide HV earthing systems to BS EN 61936-1 and BS EN 50522.

Demonstrate by design calculation and ensure that the value of touch potential imposed upon the LV systems during a HV fault does not exceed the safety limits given in Annex NA of BS EN 50522. Undertake the calculation using the recommendations and guidance given in ENA ER S 34 on assessing the rise of earth potential. Confirm and demonstrate design calculation using direct measurement of earth electrode resistance / current injection test once the system is installed.

Connect the LV cable armour to the LV switchboard common earth bar, and the neutral conductor to the LV switchboard neutral/earth busbar. Link the LV switchboard earth bars via a bolted connection. Earth the common earth bar via earth rods or an earth mat sited at least 3 m from the HV/LV transformer casing earth rod(s). Provide LV earthing systems to BS 7671 and BS 7430 for a TN-S LV system.

Ensure that all earthing systems meet any specific DNO requirement.

740 Associated LV switchboards and LV switchgear

Comply with sections Y71 and V20 of this Specification.

750 Transformers and switchgear located within a building

Mount the transformer(s) and switchgear in an internal substation. Agree with the DNO all work to be undertaken by the DNO, including the positions of all equipment and cable connections, and the electricity supply point.

Mount the HV/LV transformer and switchgear within the internal substation as shown on the drawings.

Ensure that there is adequate room for installation, maintenance and equipment replacement if required. Ensure that the substation has double doors to the outside and a lorry access road.

Ensure that the substation is adequately ventilated to dissipate the full-load transformer losses and to maintain the substation air temperature at not greater than 40°C.

Mount the transformer and switchgear on a floor smooth and level to within the tolerance required by the equipment supplier.

Where required by the equipment supplier provide the transformer and switchgear with level foundation channels set into the floor within the tolerance required by the equipment supplier.

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V11 HV ELECTRICITY SUPPLY

Fix labels to all switchgear, cable chamber covers and busbar covers with the appropriate designations and warning notices. Issue label schedules to the Contract Administrator for agreement of designation.

Provide rubber mats at least 600 mm wide to BS 61111 Class 2 (17 kV) in front of all transformers enclosures, electrical switchboards and switchgear

760 HV cable installation

Install cables as shown on the drawings and comply with section Y61 of this specification.

770 HV/LV transformer LV cable connections

Install connections as shown on the drawings and comply with section Y61 of this specification.

Provide LV connections using busbar trunking (busduct) between the transformer and LV switchboard as shown on the drawings. Provide neutral conductors of the same size and total capacity as the phase conductors.

Provided full size neutral conductors for LV circuits.

800 EQUIPMENT MANUFACTURERS

Installers must ensure that manufacturer's equipment complies with this specification. FIXING TO BUILDING 'FABRIC'

Comply with section Y90 of this Specification.

Ensure that all plinths and other builder's work suit the equipment finally ordered. Ensure that all plinths have a minimum perimeter clearance of 100mm all round.

Ensure that all concrete equipment bases are correctly cast, and are level, flat and smooth, and that any steel foundation channels are correctly incorporated.

Adequately align, support and fix all equipment to the structure in accordance with the equipment manufacturer's instructions.

900 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with section Y82 of this specification.

On every item of equipment supplied (including HV switchboards, transformers and LV switchboards) install a white engraved equipment identification and warning label, approximately 75mm wide x 25mm high and 2mm thick. On all such labels make the identification lettering black and the warning lettering red.

Within every HV switchroom and every packaged substation, wall-mount, adjacent to the HV switchboard, a drawing in a glazed frame or plastic encapsulated sleeve, showing the schematic arrangement of the HV electricity supply and distribution system including the LV switchboard. Include on it the operating instructions for the system and the switchgear settings schedule.

Where site generating plant can be interconnected with the incoming main electricity supply, provide the information required by The Electricity Safety, Quality and Continuity (Amendment) Regulations.

1000 TESTING AND COMMISSIONING

Fully test, commission and demonstrate the system in accordance with the manufacturers' recommendations, section Y81 of this specification, and as detailed below. Liaise with manufacturers of the interfaced systems to ensure all tests and demonstrations are fully co-ordinated.

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V11 HV ELECTRICITY SUPPLY

1010 Documentation

1011 System test certificate

Provide copies of the factory test certificates as part of the system test documentation.

END OF SECTION V11

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V20 LV DISTRIBUTION

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V20 LV DISTRIBUTION

1100 SCHEDULE OF INSTALLER'S SUBMITTALS

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V20 LV DISTRIBUTION

100 PERFORMANCE OBJECTIVES

To distribute low voltage (LV) electrical power, safely and reliably, around the site starting with the busbar connecting the main LV switchboard to the new transformers, and finishing at the output terminals of all site distribution boards, power distribution units, mechanical systems' supply points and/or the main switch input terminals of all items of equipment that have their own integral isolator.

To carry out a complete selectivity study of the complete LV network and determine all protection settings on site as necessary. Using Schneider devices as the Trust's preferred supplier.

To ensure that none of the electricity supplies to the existing buildings on the site are interrupted at any time during the Works except where planned well in advance and agreed in writing with the Contract Administrator.

To ensure that the LV distribution and controls provide the functionality defined by system's cause and effect requirements.

Provide multifunction meters with Modbus output and configure the meters to align with the requirements of the building energy management system and the power management system as appropriate. Energy sub-metering to be remotely viewed via the site wide BMS.

200 DESIGN PARAMETERS

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Electricity Act (As amended by the Utilities Act)

The Electromagnetic Compatibility Regulations

The Meters (Certification) Regulations

The Building Regulations

The Construction (Design and Management) Regulations

The Health and Safety at Work etc. Act

The Offices, Shops and Railway Premises Act

The Electricity Safety, Quality and Continuity (Amendment) Regulations

The Electrical Equipment (Safety) Regulations

BS 89 Direct acting indicating analogue electrical measuring instruments and their accessories. Series

BS 7430 Code of practice for the protective earthing of electrical installations

BS 7671 Requirements for electrical installations. IET wiring regulations

BS 8431 Electrical static meters for secondary metering and sub-metering. Specification

BS 9991 Fire safety in the design, management and use of residential buildings. Code of practice

BS EN 60529 Specification for degrees of protection provided by enclosures (IP code)

BS EN 60947 Low-voltage switchgear and control gear. Series

BS EN 60947-6-1 Low-voltage switchgear and control gear. Multiple function equipment. Automatic transfer switching equipment

BS EN 61111 Live working. Electrical insulation matting

BS EN 61439-1 Low-voltage switchgear and control assemblies. General rules and design verifications

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V20 LV DISTRIBUTION

BS EN 61439-2	Low-voltage switchgear and control assemblies. Power switchgear and control gear assemblies
BS EN 61439-3	Low-voltage switchgear and control assemblies. Distribution boards intended to be operated by ordinary persons (DBO)
BS EN 61439-6	Low-voltage switchgear and control assemblies. Busbar trunking systems (busways)
BS EN 62208	Empty enclosures for low-voltage switchgear and control gear assemblies. General requirements
ENA ER G5/4-1	Engineering recommendation. Planning levels for harmonic voltage distribution and non-linear equipment for transmission systems and distribution networks in the UK
ENA ETR 122	Guide to the application of Engineering Recommendation G5/4 in the assessment of harmonic voltage distortion and connection of non-linear equipment to the electricity supply in the UK
DoH HTM 06-01	Electrical services supply and distribution

210 Electric supply characteristics

Electrical supply characteristics are as stated in V11 of this specification.

220 Earthing installation

Provide earthing for the project in accordance with the requirements of a TN-S system – with separate neutral and protective conductors throughout the system.

230 LV protection coordination study

Ensure that the LV system is supplied, installed and commissioned in accordance with the selectivity study provided as part of Tender information. The design is intended to achieve full selectivity throughout the installation on the basis of Schneider devices only.

Ensure that full discrimination is achieved and demonstrate that full discrimination is achieved prior to ordering equipment. Provide details of all protective device settings required to achieve discrimination to the Contract Administrator.

300 SYSTEM DESCRIPTION

310 General

The electrical infrastructure work is to provide:

- New A substation connected to HV Ring 4
- New B substation connected HV Ring 1
- New chiller substation connected to HV Ring 2

Each substation is to house main LV switchboards and transfer switches as depicted upon drawings:

RED-HLE-02-XX-DR-E-600-001 - A Distribution LV Schematic

RED-HLE-02-XX-DR-E-600-002 - B Distribution LV Schematic

RED-HLE-02-XX-DR-E-600-003 - Chiller Distribution LV Schematic

The A and B substation electrical supplies will provide supplies to the new main switchboards associated with Project RED as well as the resupplying the Welcome Building.

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V20 LV DISTRIBUTION

The chiller substation electrical supplies will provide supplies to the new Project RED chiller upon the roof Project RED and the existing Phase 1/2 chillers.

All electrical meters forming part of the LV distribution system are specified here in V20.

Provide switchgear within the main switchboard that is compatible with the standby generation equipment as detailed in specification section V10.

Provide the main switchboards within the A and B substations with Harmonic filtering equipment.

Provide the main switchboard within the Chiller substation with power factor correction equipment.

Provide the main switchboard with surge protection devices.

The main switchboards have outgoing circuits designated as 'A' and 'B' types.

320 LV switchboards and LV switchgear

For the LV switchboards, MSB-470-02-A and MSB-180-02-B provide busbars with a fault rating of 80 kA for 1 second. For the LV switchboard MSB-240-00-C provide busbars with a fault rating of 50 kA for 1 second. Ensure all circuit breakers (MCCB) have a fault rating (Ics) of at least 80 kA. Select form 4 type 6 segregation of components for the main switchboard, using metal-enclosed cubicles, free standing, floor mounting, flush fronted switchboards arranged to form a single structure with a common busbar assembly, with feeder units, housed in individual functional units. With top exit and entry, front access. Ensure function units include plug in arrangement to allow the rest of the panel to function on the removal of any unit. Utilisation of the integral housing of outgoing devices is not acceptable.

Provide MCCBs conforming to BS EN 60947-2, electronic type and with plug in base, refer to cable schedule for breaker types.

Provide ACB's as withdrawable.

Provide restricted earth fault (REF) relays as MCAG14 with bi-directional tripping of the HV RMU circuit breaker and LV ACB.

Refer to schematics for further details.

Ensure the enclosures do not exceed a height of 2.3 m inclusive of plinths.

Ensure busbars and switchgear sections arrangement to permit future extension.

Provide a self-ventilating structure. Where there is a requirement for louvres, install filters equivalent to the maintained IP rating of the panel.

Provide interlocks, busbar shutters and covers to prevent incorrect or unsafe operation, and to prevent access to live parts.

Ensure the switchgear facilitates inspection, cleaning, repair and maintenance and ensure absolute safety during operation, inspection, and maintenance. Ensure it is possible to work safely within individual compartments whilst the remainder of the switchgear is energised. Ensure construction, including cable entry, is vermin proof.

Provide the enclosure with a degree of protection (both internal and external) to IP31.

Ensure non-equipped spare compartments are arranged such that they can be fully equipped without de-energising the Switchgear.

Ensure that where access is described as front only all required access for maintenance, replacement, alteration or inspection during the life of the panel is via the front of the panel. This requirement includes all busbar connections and small wiring.

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MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

Ensure MCCB unit includes the switch and isolation function for feeder and distribution circuits and has a fault make capability. Ensure the device is capable of breaking the circuit full load current with a performance equal to uninterrupted duty AC-22B utilisation category according to BS EN 60947.

Ensure control, indication and instrument circuits are protected by HRC fuse or MCB disconnectors. Ensure all unearthed poles of auxiliary supplies are fused, or protected by an MCB. Ensure earthed poles are connected by a removable link.

Provide busbars and connections manufactured from hard drawn copper with the same cross-sectional area throughout the length of the Switchboard.

Ensure phase and neutral busbars are run in a common compartment containing no other equipment or wiring and not requiring access for any other purpose. Ensure busbars are marked to indicate the phase colouring. Provide adequately sized vertical and horizontal busbars and connections throughout the switchgear, including adaptor chambers, braced and supported to withstand the mechanical forces and thermal effects resulting from the rated short circuit current. Ensure they are provided with certification from a recognised Testing Authority. Ensure busbars, at bus section switches are arranged to permit safe work on one bus whilst the other remains energised. In addition, ensure it is not possible for arcs to transfer across busbars in the bus section cubicle.

Provide along the full length of the structure an earthing busbar sized for the earth fault rating of the electrical system and switchgear, with provision for earth cable connections at each end.

Ensure all metallic non-current carrying parts of the switchgear are bonded together and connected to the earth busbar. Ensure all earthing connections on withdrawable equipment are first make last break design. Ensure parts are effectively earthed until they are completely withdrawn with all power and control connections disconnected. Ensure all doors are bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.

Provide provision for earthing cable armouring to the earth busbar, adjacent to the cable termination.

Provide secondary wiring in XL-LSF insulated 600V grade with stranded copper conductors 1.5 mm² minimum conductor cross sectional area and stranded conductors. Ensure wiring for CTs and VTs is a minimum of 2.5mm². Ensure wiring is terminated with crimped cable ends or lugs appropriate for the connected terminal. Where equipment terminals do not allow the connection of the specified conductor size then terminate it into adjacent terminals for transition to the specified wiring size.

Ensure the secondary wiring within the switchgear is installed in a neat and systematic manner and securely held in position (either loomed or run in conduit / trunking). Ensure wiring that passes through compartments is run in conduit / trunking that, if metallic, to be bonded to the main earth busbar. Ensure the layout of the wiring is such that individual components can be readily removed without removing other components or sections of secondary wiring.

Ensure the secondary wiring layout permits alterations to individual circuits without requiring shutdown of the complete switchboard. Ensure bus wires for control, indication, heaters etc. runs within the Switchgear and is individually fused or MCB protected at each connection point.

Ensure all wiring for external connections or between functional units in the switchgear is brought out to individual terminals on a readily accessible terminal block.

Ensure no more than two wires to be connected to a terminal.

Ensure cable terminating facilities and terminals are suitable for the specified cable type and conductor size.

Ensure terminal blocks are arranged and positioned to afford easy access for carrying out external cable termination, testing, inspection and maintenance. Ensure there is ample clear space allowed between the terminal block and the gland plate for the spreading and termination of external conductors. Provide empty trunking for these conductors.

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V20 LV DISTRIBUTION

Ensure terminal blocks are mounted in a single deck arrangement. Ensure the panel wiring is in one side of the terminal block only. Ensure all terminal blocks are shrouded or provided with transparent covers. Pinch screw type terminals are not acceptable. Ensure terminals for different voltages are in separate partitions. Provide cable supports to avoid undue strain on the cable termination.

Ensure the termination of single core cables is through a non-magnetic metal panel or gland plate and provision made for bonding and earthing any armour and/or concentric earth conductors.

330 Automatic/Manual Transfer Switches associated with LV schematics

Transfer switches are situated within the associated substations, refer to schedule:

RED-HLE-02-XX-SH-E-600-003 – ATS Schedule

Each transfer switch should consist of a single line bypass switch mechanism and a sequence logic controller to provide automatic operation.

All transfer switches and controllers should be the products of the same reputable manufacturer such as ASCO UK.

All transfer switches should provide clear indication of the Normal and Alternative Supply status including the transfer switch positions.

The chiller ATS will use a manual transfer operation, using an open transition and the transition type will be appropriately locked as required. In the event the chiller load is supported by the generator A and / or generator B and either of the generators fail/have an alarm which effects the generator a supply the generator controls will signal the Chiller ATS to remove the load from the generator by switching the ATS back to its mains feed.

400 CONTROL REQUIREMENTS

Ensure that LV system is supplied, installed, interfaced with other systems, and commissioned to provide the functionality.

Supply and install all interlinking control and sensing cables between the generator panel and transfer switches as shown on the schematic diagram and in accordance with the generator manufacturers' requirements.

Arrange for the main switchboard manufacturer to supply and install all interlinking wiring between current transformers and the check meters installed in the main switchboard, fully in accordance with specification section Y71.

Arrange for the main switchboard manufacturer to supply and install ammeters, voltmeters, power factor indicators, energy meters, combination meters together with the matching current transformers as required, and as detailed in the switchboard schedule, and specification section Y71.

500 SCOPE OF WORKS

510 Permit to work

Prior to the commencement of work and where appropriate, arrange for the issue of a permit to work and RAMS (Risk Assessment and Method Statements).

PROJECT RED ELECTRICAL INFRASTRUCTURE

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V20 LV DISTRIBUTION

600 SYSTEM COMPONENTS

610 General distribution system

Design, construct and install all switchgear and controlgear assemblies in accordance with BS EN 61439. Submit BS EN 61439 verification documentation to the Contract Administrator when the panel and assembly drawings are submitted for comment.

Ensure all LV distribution equipment, built-in components and circuits within distribution assemblies are fully rated at the following service conditions:

- ~ Maximum ambient daily temperature 40°C
- ~ Minimum ambient daily temperature 5°C

Provide all such ventilation as necessary to ensure that at 100% design load no part of the LV distribution system is subject to overheating after a period of 4 hours of continuous operation in accordance with BS EN 61439-1.

Provide only equipment and components not foreseeably identified for withdrawal from either manufacture or continuing manufacturer support with a view to maintaining a supported operational life of fifteen years. Do not use any equipment or components identified as end of line or otherwise not expected to have manufacturer continuing support and spares availability.

Fit each assembly with a durable legible label located in a clearly visible place. Provide the following information:

- ~ manufacturer's name or trade mark
- ~ type designation or identification number or other means of identification
- ~ date of manufacture
- ~ IEC 61439-X (the specific part "X" shall be identified)

Provide all multi-sectional assemblies with a supplementary protective conductor (earth bar) running the entire length of the complete assembly and connect all earth bonds, cable glands, etc within the assembly to it as necessary.

Provide all doors, covers and lids with robust earth tags with an expected life equivalent to that of the assembly or enclosure to which it attaches.

Provide thermal imaging ports to enclosure doors with direct line of sight of all mains terminals. Ensure that each port is retained by a tamper proof fastening mechanism that allows the port to be opened for non-invasive thermally imaging without exposure to hazard. Ensure that thermal imaging ports do not compromise the IP rating of the enclosure when not in use. Ensure that all internal material between a thermal imaging port and the associated mains terminals is thermally transparent.

Install electrical insulating matting to BS EN 61111 Class 1 (7.5 kV) as necessary in each switchroom. Ensure that all installed matting lies flat to the floor without movement in normal operation.

Ensure that the HMI display provides a backlit auto-dimming LCD minimum 7" colour display with resistive / capacitive touch screen technology and configurable audible sounder. Ensure that the HMI display has a low level of display latency (ie display responses quickly without appreciable time lag).

Ensure all power and control cables are LSZH/LSF.

Ensure all threaded electrical conductor terminations are tightened to the correct torque in accordance with the equipment manufacturer's recommendations. Provide all torqued connections with a torque mark seal. Provide details of all torque settings in the O&M manual and inside all panels.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

Provide 10% spare MCCB device chambers and 10% spare metering space, all with removable blank plates to enable easy future fitting of additional device(s) to the following panels

Provide 10% spare ACB device chambers with removable blank plate to enable easy future fitting of additional device(s) to the following panel:

Install Type 1 surge protection devices at the service entrance / main distribution board or other appropriate location as set out in specification section W52. Provide switch-fuse or circuit breaker protection to surge protection devices.

Provide all necessary top boxes for all cable ways unless otherwise specified.

Provide insulated safety rescue hooks in switchrooms. Mount insulated safety rescue hooks with their operating instructions on a wall of the switchroom next to other health and safety notices and charts.

Provide craneage to execute lifting of all enclosures referenced in accordance with the overall construction programme. Provide all associated Method Statements, Risk Assessment and weight load details.

611 Rated diversity factor

Provide all distribution assemblies with rated diversity factor (assumed loading) in accordance with BS EN 61439-2. Ensure each individual circuit is capable of carrying the full rated current assigned to them.

612 Lamp indications

Ensure all indicator lamps use LED technology and have uniform luminance with a viewing angle in excess of 120 degrees.

Ensure LED indicator lamps are powered by extra-low voltage drivers with integral current-limiting functionality and reverse-polarity protection. Provide a push-to-test facility. Ensure LED indicator lamps are replaceable without the use of special tools and are of an industry-standard size and fitting.

613 Panel labels for information and warning

Fix permanent engraved labels to all panels to provide information and warning to suitably qualified persons carrying out operation and maintenance. Include the following:

- ~ a label indicating the function of each switch and indicator lamp
- ~ a label on each openable panel door reading: "WARNING - ISOLATE PANEL BEFORE MAINTENANCE"
- ~ a self-adhesive warning label to each door giving access to 400-Volt circuits
- ~ a key diagram showing the source and identification of all power supplies entering a panel, their function and means of isolation

614 Device locking

Provide all protection devices complete with all necessary lockable fittings and padlocks and supply complete with a minimum of three keys for each padlock. Including lockable cover flaps to on/off controls.

620 Wiring Systems

Support all wiring systems in accordance BS 7671 such that they are not liable to premature collapse in the event of fire. Do not use non-metallic cable clips, cable ties or cable trunking as the sole means of support. Use fire-resistant means of support designed to prevent cables from falling out into escape routes in the event of fire.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

630 Incoming supply

631 Incoming cable

Refer to schematics for distribution system:

RED-HLE-02-XX-DR-E-600-001 - A Distribution LV Schematic

RED-HLE-02-XX-DR-E-600-002 - B Distribution LV Schematic

RED-HLE-02-XX-DR-E-600-003 - Chiller Distribution LV Schematic

640 Sub mains distribution

641 Sub mains cable

Supply, install and connect sub mains cables from MSB-470-02-A, MSB-180-02-B and MSB-240-00-C to the distribution boards, isolating switches and other plant as detailed on the drawings or in the cable schedules. Refer to cable schedule RED-HLE-02-XX-SH-E-600-001.

642 Containment and support for sub mains cable

Supply and install sub mains cable containment and support as detailed on the drawings or in the schedules.

Provide all necessary top boxes for all cable ways unless otherwise specified.

650 Final distribution boards, isolating switches, motor control panel and power distribution units

Supply and install the following components in accordance with specification section Y71 and the following requirements:

Distribution boards - Supply and install distribution boards as detailed in the distribution board schedule.

Isolating switches - Supply and install isolating switches for large plant as specified in the distribution board schedules or shown on the drawings.

Motor control panels - Connect, in accordance with specification section Y61, the sub mains cable direct into the main switch of every such panel where a separate isolating switch is not specified.

Power distribution units (PDU) - Supply and install PDUs as shown on the drawings. Ensure PDUs have the following features:

Manufacturers - Unless agreed otherwise by the Contract Administrator in writing ensure that all switchgear is made and supplied by one manufacturer.

660 Conduit and cable trunking

Provide conduit and cable trunking complying with specification section Y60.

Provide conduit that is galvanised metallic/non-metallic and the trunking that is galvanised metallic/non-metallic in accordance with specification section Y60.

Ensure that the conduit meets the performance classification 3 (Medium) in accordance with BS 61386-1 and the trunking performance as defined in BS EN 50085 as General High Performance , with the exception of specific requirements designated on drawings or schedules.

670 Cable support and management systems

Provide cable support and management systems complying with specification section Y63.

Provide metallic cable support systems as shown on drawings or specified, with Class 2/3/4/5 corrosion protection in accordance with BS EN 61537 Table 1.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

Provide non-metallic cable support systems as shown on drawings or specified. The cable supports must be suitable for the operating temperature, loads and have a high level of impact resistance.

700 EQUIPMENT

710 Main switchboard, meters and monitoring

711 Main switchboard type and construction

Supply and install main switchboard(s) with the following features:

Fit all incoming and outgoing cables from above/below with watertight glands. Install all minor control cables in glanded and watertight conduit.

Provide all switchgear and switch fuses with means of locking them in the open/closed position as appropriate.

Label all switchgear and switch fuses with permanent identification labels using the descriptions on the drawings and contained in specification section Y82.

Allow for the future expansion of cubicle type switchboards.

712 Main switch

Supply and install a main switch with the following features:

713 Outgoing circuits

Provide outgoing circuits as follows:

Provide busbars within the main switchboard rated at Insert Rating A and arranged as a single common supply to all outgoing circuits.

Install within the outgoing ways of the main switchboard ACBs, MCCBs of the ratings shown on the drawings.

714 Meters

Ensure all meters are sourced from established manufacturers and are expected to have continuing availability of manufacturer's spares and service support.

Provide multi-function electronic meters and associated current transformers for the incoming supplies and outgoing feeders as shown on the drawings. Use multi-function meters capable of measuring the following parameters:

- ~ voltage
- ~ current
- ~ power factor
- ~ frequency
- ~ active power
- ~ reactive power
- ~ apparent power
- ~ active energy
- ~ reactive energy
- ~ maximum demand

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

- ~ total harmonic distortion (THD)
- ~ individual harmonic analysis

Ensure meters are fully bi-directional, can meter energy in four quadrants and have a self-illuminating electronic display. Provide meters with the following communication ports:

- ~ Ethernet
- ~ RS232/RS485

Provide meters with the Modbus communication protocols.

Provide meters with date and time stamped event logging and recording facilities, and battery-backed memory backup. Ensure meters are also capable of supporting sub-metering and cost allocation applications.

Ensure meters are compatible with and connected to the site BMS/Energy monitoring and management/client system to allow remote recording of meter readings. Include for the metering bus cable to terminate inside/outside the LV switchpanel in an accessible location for the mechanical installer to connect into wider network and system(s).

Provide within the main switchboard, energy check meters as specified by the drawings/schedules and as listed in the current edition of Schedule 4 of The Meters (Certification) Regulations.

Mount on the incoming switchgear panel a true RMS ammeter, a true RMS voltmeter and a power factor meter. Ensure that the ammeter is switchable between phase and neutral currents, and that the voltmeter is switchable to measure the voltages between phases and between each phase and neutral.

Mount on the incoming switchgear panel an instrument to measure, display and record the true RMS voltage, current and the power factor of each phase of the incoming supplies. Include the harmonic distortion of the incoming supply currents, to establish compliance with ENA Engineering Recommendation G5, and the need to install measures to reduce mains harmonic distortion.

715 Monitoring systems

Provide, install, and commission an electrical monitoring system, also refer to section V10 clause 400 of this specification.

Provide the monitoring system to interface with Modbus protocols, BMS.

Ensure the status and alarm of all internal components are monitored together with measurement of electrical characteristics; voltage, current, true power, apparent power and frequency, including;

- ~ status and alarm of all LV ACBs/MCCBs (including on/off/tripped/withdrawn)
- ~ status and alarm of the transformers
- ~ status and alarm of the generator set
- ~ status and alarm from all new power distribution units

Develop the overall points status and points lists for the entire electrical installation and issue to Contract Administrator for comment.

720 Busbars

Supply and install busbars in accordance with specification section Y62 and as the following.

Provide switchboard busbars with air insulation unless otherwise specified.

Ensure that the conductor bars are of pure electrical grade copper/aluminium and the busbars are fully insulated with non-flammable low smoke zero halogen (LSZH) insulation

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

Provide busbar chambers with labels stating their current carrying capacity.

Supply and install horizontal busbars. Use busbars rated as shown on the drawings.

Ensure the busbar trunking enclosure material and finish is:

- ~ galvanized cold rolled steel
- ~ powder coated cold rolled steel
- ~ extruded aluminium channels with re-enforced polyester covers
- ~ finish indicated by the drawings and/or specification
- ~ ventilated powder coated cold rolled steel

Ensure the feed unit is the end-feed type with an ingress protection rating of IP4155.

Provide feed unit with flanged end.

Provide feed unit for direct bolting-on to power supply.

Provide feed unit capable of accepting separate power supply feeds.

Ensure the busbar is supported by proprietary brackets.

Provide non-proprietary supports but ensure that any support system used will be suitable for the manufacturer's support arrangements provided on the busbar trunking.

Provide a separate protective conductor bar integral to the busbar trunking.

730 Harmonic filtering

Ensure that the equipment complies with specification section Y71 and the following:

Allow sufficient space adjacent to MSB-470-02-A and MSB-180-02-B for the retrofitting of harmonic filter equipment.

800 FIXING TO BUILDING 'FABRIC'

Comply with specification sections Y90 and Y93.

Fix all busbars to the fabric of the building using the manufacturers' purpose made fixings.

900 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with specification section Y82.

Provides copies of the following in a document holder within each relevant panel:

- ~ schedule of torque settings
- ~ control fuse schedule
- ~ spares schedule of recommended consumables
- ~ copies of record drawings

1000 TESTING AND COMMISSIONING

Comply with specification section Y81.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

Submit to the Contract Administrator for comment separate method statements for the testing, commissioning and demonstration one month in advance of commencement of those activities.

Undertake all necessary testing and commissioning of LV distribution system to verify and fully demonstrate the following:

- ~ the proper functioning after installation
- ~ that performance meets with the specified design intent and statutory regulations

Capture and record all testing and commissioning performance data and include in the operating and maintenance instruction manuals as a baseline for future operation and maintenance.

Include as fitted drawings, record information, room fitted schematic, safety signage and HV/LV AP Training and familiarisation (all systems) prior to handover.

Prior to energisation, testing or on-site commissioning perform the following in accordance with the appropriate British Standards:

Factory testing

Subject the following LV equipment to a full factory witness test allowing for up to four people including travel and expenses. Provide at least two weeks' notice of the date of testing to the Contract Administrator

Perform and demonstrate the satisfactory completion of the following tests:

Pre-commissioning

Systematically clean all LV distribution panels of all debris, foreign bodies and dust immediately before testing and commissioning. Retain covers in place after cleaning unless it is necessary to remove for testing and commissioning.

Inspect all electrical distribution systems prior to energisation to ensure that the installed system complies with the requirements of this specification.

On-site testing and commissioning

Undertake thermal imaging of all mains terminations under site loading and include results in the operating and maintenance instruction manuals.

Demonstrate that a consistent phase rotation is maintained throughout the system including connection to secondary and life safety supplies.

Provide two weeks' notice of all tests to the Contract Administrator.

In addition to the above pre-energisation checks, prove the following:

Integrated LV distribution system functional testing of:

Submit test methodology for all the above tests to Contract Administrator for acceptance four weeks before test commencement.

Submit all necessary manufactures Test Certificates for all items of equipment used to the Contract Administrator in electronic format and include same in the operating and maintenance instruction manuals.

Include schedule of all recorded test results in the operating and maintenance instruction manuals.

1100 SCHEDULE OF INSTALLER'S SUBMITTALS

Comply with specification section A30.

Submit the following for the Contractor Administrator's comment:

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V20 LV DISTRIBUTION

- ~ Cable and containment support system sizing calculations (additionally and specifically refer to BS 8519 annex E where appropriate)

Submit operating and maintenance instructions manuals for:

- ~ distribution system
- ~ main switchboard
- ~ meters
- ~ power factor correction equipment
- ~ testing and commissioning certificates
- ~ terminal imaging results
- ~ inspection details

Provide all documentation necessary to comply with the requirements of The Electromagnetic Compatibility Regulations.

At tender submission stage, provide details of the physical dimensions, weights and lifting instructions of all major LV systems components (eg main switchboard whole or split in sections) to the Structural Engineer.

Submit a schedule of all recommended spares and special tools required to safely maintain the LV distribution systems within six weeks of tender acceptance.

Submit details of instruction and training programme for the employer's staff in accordance with specification section A37.

For all LV assemblies provide details of BS EN 61439 verification documentation when panel assembly drawings are submitted for comment.

Provide copies of letters of conformity and test certificates for all equipment supplied as part of the LV distribution system.

END OF SECTION V20

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

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PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

100 PERFORMANCE OBJECTIVES

To provide a complete artificial lighting system within the Infrastructure Compound that will meet the design criteria.

To ensure the lighting system solution and installation provides a safe, comfortable, balanced and interesting visual environment. To consider the vertical illuminance of surfaces within an environment, in conjunction with, the recommended horizontal working plane illuminance.

To achieve good quality colour appearance and colour rendering by ensuring that light source colour is within a range of three MacAdam ellipses or less, and has a minimum colour rendering index of 85.

To achieve the recommended levels of illuminance, luminance, uniformity and glare control by selection of particular luminaire, lamp source and optical control, together with the selection and recommendation of the associated environmental reflectance properties.

To ensure that all luminaires and ancillary controls are suitably selected to be compatible with the environment in which they are installed.

To ensure that lighting systems within lift motor rooms and lift shafts comply with the requirements of BS EN 81.

200 DESIGN PARAMETERS

210 Reference documents

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Building Regulations - Part L – The conservation of fuel and power

The Building Regulations - Part M – Access and facilities for disabled people

Health and Safety (Display Screen Equipment) Regulations. (SI 1992/2792 and HSE L26)

Requirements of the Building Control and Fire Officers

2000/55/EC	Directive of the European Council - Energy efficiency requirements for ballasts for fluorescent lighting
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BS 67	Specification for ceiling roses
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BS 476-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
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BS 1363	13 A fused plugs, socket-outlets, adaptors and connection units
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BS 4533-102.19	Luminaires. Particular requirements. Specification for air-handling luminaires (safety requirements)
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BS 5266-1	Emergency lighting Part 1: Code of practice for the emergency lighting of premises
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BS 5733	General requirements for electrical accessories. Specification
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BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
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BS 6972	Specification for general requirements for luminaire supporting couplers for domestic, light industrial and commercial use
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PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

BS 7211	Electric cables. Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire
BS 7629-1.	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS EN 12464-2	Light and lighting. Lighting of work places. Outdoor work places
BS EN 13032-1	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format
BS EN 13032-2	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for indoor and outdoor work places
BS EN 13032-3	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for emergency lighting of work places
BS EN 13032-4	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires
BS EN 50107-3	Product standard covering luminous signs with discharge lamps and/or LED (light emitting diodes) and/or EL (electroluminescent) light sources with a nominal voltage not exceeding 1000 V, with the exclusion of general lighting, traffic- or emergency related purpose.
BS EN 50525 (All Parts)	Electric cables - Low voltage energy cables of rated voltages up to and including 450/750 V
BS EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
BS EN 60079 (All Parts)	Explosive atmospheres
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60598 (All Parts)	Luminaires
BS EN 60947 (All Parts)	Low-voltage switchgear and control gear
BS EN 61000-3-2	Electromagnetic compatibility (EMC) Limits. Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
BS EN 61000-4-5	Electromagnetic compatibility (EMC): Testing and measurement techniques – Surge immunity test
BS EN 61347 (All Parts)	Lamp controlgear
BS EN 61535	Installation couplers intended for permanent connection in fixed installations
BS EN 61547	Equipment for general lighting purposes. EMC immunity requirements
BS EN 61558-2-1	Safety of power transformers, power supplies, reactors and similar products. Particular requirements and tests for separating transformers and power supplies incorporating separating transformers for general applications
BS EN 62031	LED modules for general lighting. Safety specifications
BS EN 62035	Discharge lamps (excluding fluorescent lamps). Safety specifications
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

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MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

BS EN 62384	DC or AC supplied electronic control gear for LED modules. Performance requirements
BS EN IEC 62386-207.	Digital addressable lighting interface. Particular requirements for control gear. LED modules (device type 6)
BS EN IEC 62442-3:	Energy performance of lamp controlgear. Controlgear for tungsten-halogen lamps and LED light sources. Method of measurement to determine the efficiency of controlgear
BS EN 62471	Photo biological safety of lamps and lamp systems
BS EN 62504	General lighting. Light emitting diode (LED) products and related equipment. Terms and definitions.
BS EN 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50V. Safety specifications
BS EN 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50V. Performance requirements
BS EN 62707-1	LED-binning. General requirements and white colour grid
BS EN 62717	LED modules for general lighting. Performance requirements.
BS EN 62722-2-1	Luminaire performance. Particular requirements for LED luminaires
BS EN 62776	Double-capped LED lamps designed to retrofit linear fluorescent lamps. Safety specifications.
BS EN 62931	GX16t-5 capped tubular LED lamp. Safety specifications
BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs.
BS EN ISO 9241	Ergonomics of human-system interaction
BS ISO 3864-1:2011.	Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings
CIBSE	Code for Lighting
CIBSE	SLL Lighting Guides
CIBSE	Commissioning code L – Lighting
HBN	NHS Estates, Health Building Notes – Engineer to review according to Department or Facility of health care building applicable
ICEL 1001	Scheme of product and authenticated photometric data registration for emergency lighting luminaires and conversion modules
DoH HTM 06-01	Electrical services supply and distribution
DoH HTM 06-02	Electrical safety guidance for low voltage systems

220 Design criteria

Achieve the average maintained illuminance values for the Infrastructure Compound, specified in CIBSE Guide LG2 and as below:

Lamp cleaning interval	1 year (assuming a typical operation of 14 hours/day for 6 days/week within a clean office environment)
Final lighting circuit ratings	230V 50Hz SP&N – 6A/10A/16A circuit protective device (CPD) dedicated radial circuits.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

Lighting Circuits Protection	Include RCD protection for domestic installations on lighting circuits, as per BS 7671 and ensure that the design reduces the chance of nuisance tripping.
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Ensure the lighting system provides a uniformity of illuminance of not less than 0.8, over the task area and a diversity of illuminance, over the core area, not exceeding 5:1.

300 **SYSTEM DESCRIPTION**

310 **General**

The lighting circuits will be interleaved and provided from the separate final circuit distribution boards (A and B).

All meters for lighting energy consumption are situated at the distribution board

Refer to the Lighting drawings for details of the lighting for specific areas of the scheme and luminaire schedule.

Substations and Medical Gas Store have surface mounted luminaires each with diffuser or controller attachments and, where applicable, IP rated corrosion resistant or vandal-proof luminaires.

Externally wall mounted luminaires and wall mounted flood luminaires to have diffuser or controller attachments and have adequate IP rated corrosion resistance.

400 **CONTROL REQUIREMENTS**

410 **General**

Supply and install the lighting system controls and control equipment of the type and manufacture as indicated on the Luminaire Schedule.

Install lighting controls and equipment within the locations and at the positions indicated on the drawings.

Supply and install local wall-mounted manually-operated lighting control switches at the positions indicated on the drawings.

Photocell to be installed on the northern elevation to control externally wall mounted D type luminaires upon infrastructure building via contactor. Individual photocells to be installed on the northern elevation to control externally wall mounted D type luminaires upon each generator container.

An externally rated IP switch to be located upon the entrance of the infrastructure compound is to control local floodlighting, to be used during times of maintenance.

Provide separate emergency lighting test key switches local to each room. External emergency lighting to have test key switch local to the distribution board.

500 **SCOPE OF WORKS**

510 **Responsibilities**

520 **Electrical installer's responsibilities**

The electrical installer's responsibilities include those described in the appropriate 'A' sections of this specification, and also include, but are not limited to, those described in this clause.

Install a lighting system comprising final circuits distribution, control devices and equipment, luminaires and optical accessories, complete with lamps, throughout all areas and locations of the building(s).

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

Supply and install luminaires of the type and manufacture indicated on the Luminaire Schedule

Install all luminaires complete with fixings, suspensions, glassware, louvres, diffusers, reflectors, optical controllers, control gear and lamps, together with all required ancillary components, accessories and attachments, as described within this specification and as detailed on the drawings, and connect them to the final lighting circuits as indicated in the Distribution Board Schedules.

Install luminaires throughout the building(s) within locations and at the positions indicated on the drawings, ceiling-mounted surface luminaires, in plant rooms and stores, etc; and wall-mounted luminaires of both the decorative and functional type.

Further to clause A31.100 of this specification, the layout of components and luminaires on the drawings are diagrammatic only, therefore make due allowance in the tender for final positions of all items of equipment to be within one metre, either side of the position indicated.

Within the substations and medical gas room, ensure the luminaires are positioned to coordinate with the layout and installation of all plant and associated equipment.

Wire and connect all luminaires to final radial circuits emanating from local distribution boards in accordance with the lighting circuit references detailed within the schedules and indicated on the drawings.

600 SYSTEM COMPONENTS

610 General

Install all components in accordance with the relevant clauses of the appropriate 'Y' Sections of this specification.

620 Conduit system

Comply with Section Y60 of this specification.

Install a conduit cable containment system for all unarmoured insulated lighting final circuit cables and where applicable for the fixing of luminaires.

Provide throughout the various areas of the building a surface or concealed, class 4 galvanised steel conduit containment system fixed to walls and to soffits of structural slabs.

Install sections of conduit from the lighting distribution cable trunking and extend to luminaire outlet positions or wall accessory outlet positions and terminate at a conduit outlet box of the appropriate type.

630 Cable trunking system

Comply with Section Y60 of this specification.

Install a trunking cable containment system for all unarmoured insulated, and all insulated and sheathed, lighting final circuit cables.

Supply and install, as indicated on the drawings, a surface, or concealed cable trunking containment system for the lighting final circuit cables and where applicable for the fixing of luminaires.

Provide the distribution cable trunking comprising galvanised steel, single compartment distribution, or multiple compartment distribution sized in multiples of 50 mm x 50 mm, and as particularly detailed on the drawings.

Install a cable trunking containment system to avoid multiple runs of conduit, comprising either a dedicated or shared (ie lighting and small power supplies) single compartment system, or a multi-compartment trunking for the distribution of various cable supplies and cable systems.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

640 Wiring system

Comply with Section Y61 of this specification.

Wire and connect all luminaires to final radial circuits emanating from local distribution boards in accordance with the lighting circuits references detailed in the schedules and indicated on the drawings.

Use single core 6491B (XLPE-LSZH) insulated cables with stranded copper conductors to BS 7211, rated at 450/750V, with minimum conductor size of 1.5mm².

Run cables enclosed within a galvanised cable trunking with conduit extending to luminaire, controls and switch locations.

Make final connections to luminaires using 6A (minimum) 3- or 4-pin plug-in ceiling roses, with self-retaining plug and socket as appropriate, with 3- or 4-core 1.5mm² insulated and sheathed LSF heat resisting 85°C high-temperature flexible cable.

Mount such plug-in ceiling roses direct to the associated trunking or conduit box.

Ensure all cables and cores of cables connected within a luminaire or passing through will not suffer damage or deterioration due to heat or UV radiation generated by the luminaire or its lamps.

Locate every such ceiling rose above the associated luminaire position and provide sufficient length of flexible cable.

Ensure containment and accessories are installed at a suitable height to facilitate future access for maintenance, from the floor.

Within substations, medical gas room and external locations, install the lighting system using surface-mounted galvanised conduit, weatherproof luminaires and accessories (minimum IP44 for semi-exposed and IP55 for fully exposed).

Where indicated on the drawings, suspend linear fluorescent luminaires, using galvanised steel suspension chains fixed to the containment system by hook backplates, to a level approximately 2.5m AFFL, and provide the final connection to every such luminaire using a plug-in ceiling rose with heat-resistant flexible cable of the appropriate grade and rating.

700 EQUIPMENT

710 General

Ensure all the luminaires are of the LED type and are the most recent generation available.

720 Luminaires

Comply with Section Y73 of this specification.

Install recessed luminaires fixed to the suspended ceiling grid or direct to the structure using purpose incorporated fixing positions, together with conduit accessories, suspension rods, side frame brackets, clamps, clips or other equal method.

730 Control devices

Ensure that each and every control device is suitably rated with regard to the circuit protective device and the load being switched taking account of the load type (e.g. inductive loads), and the in-rush current characteristic of the load.

Only install control devices with a minimum in-rush current withstand-capability greater than 125% of the cumulative in-rush current of the connected loads.

731 Switches

Comply with Section Y74 of this specification.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V21 GENERAL LIGHTING

Supply and install all lighting control switches, including wall-mounted type, at the positions shown and connect to the lighting switch control circuits shown on the drawings.

Ensure switches are of the appropriate 'way' type and grouped into ganged switch plates.

Install surface-mounted switches throughout.

Install all lighting control switches at a height between 900 mm to the bottom edge and 1200 mm to the top edge as measured from finished floor level, unless otherwise indicated on the drawings, or as particularly detailed elsewhere in this specification.

Ensure local manually-operated switches are positioned adjacent to all respective access doors to and from each area.

Supply and install manually-operated lighting control switches, rated at 20A per pole, of the grid switch assembly construction, surface or flush mounting to suit, of the appropriate 'way' type, and complete with rocker or key-pattern switch inserts.

Install white moulded finish faceplates within flush-mounted installations and metal-clad style switches for surface-mounted installations within plant rooms, etc.

Where different supply phases are present within multi-gang switches, provide voltage warning labels (eg "Danger 400V"). Ensure warning labels are permanently fixed internally and externally to every such switch.

Select lighting control switches from the manufacturers' ranges to match socket outlets and other accessories.

732 Time switches

Ensure that all time switches comply with BS EN 60730.

733 Photoelectric control units

Ensure that all photoelectric control units comply with BS 5972.

800 INSTALLATION

810 General

When interconnecting sensors, controllers and luminaires, only use the manufacturers' recommended cable types.

811 Cleaning and cable inspection

Upon completion of the installation, clean all detector lenses using anti-static cleaning fluid.

Check that all cable connections are secure.

812 Labelling

Provide identification labels for all equipment and sensors. Label the output circuits, describing each item's purpose.

813 Installing cabling and containment

Test for and confirm the integrity of all cable glands.

Ensure that cables are installed in one length. Joint cables at the equipment and connection box only.

814 Installing luminaires

Install luminaires in accordance with the manufacturer's instructions.

Adjust the orientation of adjustable luminaires to give the optimum performance.

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V21 GENERAL LIGHTING

900 FIXING TO BUILDING FABRIC

Comply with Section Y90 of this specification.

When fixing accessories to the structural steelwork, use proprietary brackets or clamps. Do not drill or weld to the structural steelwork.

1000 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with Section Y82 of this specification.

1100 TESTING AND COMMISSIONING

Comply with Section Y81 and clause A32.900 of this specification.

Ensure that the testing and commissioning complies in general with the CIBSE Commissioning Code L: 2018, and the results presented under the following headings;

- Lighting and Lighting Control equipment testing
- Lighting quality
- Lighting control performance
- Emergency lighting

1200 SCHEDULE OF INSTALLER'S SUBMISSIONS

1210 Submittals with tender

1220 Submittals during contract

Submit the following for the Contract Administrator's comment:

- ~ selected manufacturer's design proposals
- ~ manufacturer's technical submissions and proposals for the supply and installation of all items of equipment and associated components
- ~ lighting system samples
- ~ lighting design input data and calculation output sheets
- ~ manufacturer's design and installation drawings
- ~ installation and commissioning programme
- ~ installation method statements
- ~ inspection details and certificates
- ~ operating and maintenance manuals for all items of installed components and equipment
- ~ record drawings
- ~ completion certificate(s)
- ~ test and commissioning certificates
- ~ manufacturer's test certificates to verify compliance with Category TP(a) for luminaires specified with thermoplastic diffusers

END OF SECTION V21

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V22 GENERAL LV POWER

100 PERFORMANCE OBJECTIVES

To provide distributed power supplies throughout the building and external areas using 400-V three-phase 50-Hz circuits and 230-V single-phase 50-Hz circuits and any other voltages/frequencies within the definition of LV.

To provide a system of sufficient capacity to adequately meet the load characteristics of all individual circuits whilst remaining within equipment voltage and frequency tolerances.

To provide a means of fault clearance and isolation on every circuit and coordinated protection of cables and switchgear.

To provide a system designed to provide complete selectivity under fault conditions. To ensure that circuit design makes allowances for anticipated fault levels, installed cable length, environmental influences, diversity, installation methods, and that circuit disconnection is achieved safely within periods prescribed in BS 7671.

To provide outlets that are suitable for the connected equipment and the environment in which they are installed.

To ensure that all appliances are fused for the corresponding load, taking into account the manufacturer's recommendation and any inrush current.

200 DESIGN PARAMETERS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Building Regulations

The Disability Discrimination Act

The Electricity at Work Regulations

BS 1363 13 A plugs, socket-outlets, adaptors and connection units

BS 5424-3 Specification for controlgear for voltages up to and including 1000 V A.C. and 1200 V D.C. Additional requirements for contactors subject to certification

BS 5467 Electric cables. Thermosetting insulated, armoured cables of rated voltages 600/1000 V and 900/3300 V for fixed installations. Specification

BS 5724 Medical electrical equipment. Particular requirements for safety.

BS 6004 Electric cables. PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting

BS 6231 Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring

BS 6396 Electrical systems in office furniture and educational furniture. Specification

BS 6724 Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1000 V and 1900/3300 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification

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BS 7211	Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire
BS 7346	Components for smoke and heat control systems
BS 7540-3	Electric cables. Guide to use for cables with a rated voltage not exceeding 450/750 V. National standard cables not included in HD 21 and HD 22
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7657	Specification for cut-out assemblies up to 100 A rating, for power supplies to buildings
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS EN 50525	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U_0/U)
BS EN 50565	Electric cables. Guide to use for cables with a rated voltage not exceeding 450/750 V (U_0/U)
BS EN 55014	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus
BS EN 60269	Low voltage fuses
BS EN 60309-1	Plugs, socket-outlets and couplers for industrial purposes. General requirements
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories
BS EN 60335	Household and similar electrical appliance. Safety
BS EN 60601-1	Medical electrical equipment. General requirements for basic safety and essential performance
BS EN 60742	Isolating transformers and safety isolating transformers. Requirements
BS EN 60896-22	Stationary lead-acid batteries. Valve regulated types. Requirements
BS EN 60898	Electrical accessories. Circuit-breakers for overcurrent protection for household and similar installations: Series
BS EN 60909-0	Short-circuit currents in three-phase A.C. systems. Calculation of currents
BS EN 60947-2	Low-voltage switchgear and controlgear. Circuit-breakers
BS EN 60947-3	Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN 61180	High-voltage test techniques for low-voltage equipment. Definitions, test and procedure requirements, test equipment
BS EN 61439	Low-voltage switchgear and control gear assemblies: Series
BS EN 62040	Uninterruptible power systems (UPS): Series
BS EN 62196-2	Plugs, socket-outlets, vehicle connectors and vehicle inlets. Conductive charging of electric vehicles. Dimensional compatibility and interchangeability requirements for A.C. pin and contact-tube accessories
IEC 60364-7-710	Electrical installations of buildings. Requirements for special installations or locations. Medical locations.
IET Guidance Note 7	(GN7) Special locations

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HTM 02-01	Medical gases. Medical gas pipeline systems
HTM 05-03	Firecode - fire safety in the NHS. Operational provisions. Part F: The prevention and control of arson in NHS healthcare premises
HTM 06-01	Electrical services. Electrical services supply and distribution
HTM 06-02	Electrical services. Electrical safety guidance for low voltage systems
HTM 06-03	Electrical services. Electrical safety guidance for high voltage systems
HTM 08-03	Specialist services. Bedhead services

The British Council for Offices Guide to Specification

The Base Build Definition Rev B

The Fire Strategy

Comply with the requirements in the following MEP related BREEAM New Construction 2014 credits to achieve a minimum rating of Excellent: MAN 01, HEA 01, HEA 02, HEA 03, ENE 01, ENE 02, ENE 03, ENE 06, POL 04, TRA 03, WAT 01, WAT 02, WAT 03 and MAT 04.

210 Design Criteria

Design distributed power fully in accordance with BS 7671, taking into consideration, amongst other applicable design criteria, the following in respect of BS 7671:

- ~ The requirements of Chapter 52 in respect of the general design and selection of wiring systems.
- ~ The requirements of Chapter 43 in respect of protection provided against overcurrent.
- ~ The requirements of Chapter 41 in respect of protection against electric shock.

Adopt a grouping factor not exceeding 0.8, ambient temperature of 30°C, XLPE insulated conductors, and equally sized phase, neutral and CPC conductors.

Configure ring and radial final circuit arrangements in accordance with BS 7671 as detailed in Regulation 433.1 and informed in Appendix 15. Ensure main and radial final circuits are designed to minimise disruption on failure of a circuit or operation of a protective device.

Size circuit components to achieve disconnection times as described in BS 7671.

Provide RCD protection on power circuits to meet the requirements of BS 7671 and of the rating indicated by the distribution board schedules.

Space outlets on different phases not less than 2 m / 3 m apart.

Allow 20% spare capacity in all final containment routes to enable additional outlets to be added.

Connect power supplies to all equipment associated with life safety and fire protection installations to the essential sections of the distribution systems via dedicated circuits, and design in accordance with BS 9999.

300 SYSTEM DESCRIPTION

310 General

311 Wiring types

Take responsibility for the final cable selection.

Provide internal cabling in accordance with the following:

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- ~ BS 7211, 6491B LSZH, insulated only, single-core cable, 450/750-volt grade, contained in steel trunking and/or conduit
- ~ BS 6724, XLPE insulated, LSZH bedded, single wire armoured, LSF sheathed cable, 600/1000-volt grade unless otherwise specified. Arrange single-core wire armoured cables in trefoil and provide aluminium wire armour and non-ferrous or insulated gland plates to prevent circulating currents.

Provide copper/LSZH singles in trunking and/or conduit for the final circuits from the distribution boards.

Provide external cabling in accordance with the following:

- ~ BS 5467, XLPE insulated, single wire armoured, pre-sheathed cable, 600/1000-volt grade.

Wire all life safety systems in accordance with the requirements of BS 8519.

312 Installation methods and containment

Use single core cables within conduit to feed final socket outlets, unless otherwise specified, to allow re-wiring.

Provide final circuit wiring installed in a system of containment throughout its length.

Provide galvanized steel cable trays and ladders where several cables are installed in close proximity and in accordance with the layout drawings. Ensure that the tray and ladder are medium-duty grade and post-dipped galvanized unless otherwise specified. Ensure that tray and ladder routes are continuous and arranged to provide horizontal cable ways between panels and distribution boards.

Paint exposed threads with rust-resisting paint. Ensure that conduit and trunking installations are completed prior to pulling in any circuit cables.

Ensure that the trunking is galvanized unless otherwise specified.

Ensure that the insulation of the cabling system selected is equal to the maximum circuit voltage present within the trunking compartment and that the cable can operate satisfactorily within the electromagnetic environment prevailing in the trunking compartment, ie twisted pair and screened cabling, to provide maximum immunity and to minimise emissions.

Where SWA cabling terminates in enclosures/isolators, provide “banjo” type connections to an earth lug to the respective earth terminal.

Provide PIN racks in accordance with specification section Y60. Wrap cables around these PIN rack to avoid unnecessary stress being exerted onto the cables.

Support cables located in escape routes in accordance with BS 7671 such that they are not liable to premature collapse in the event of fire. Do not use non-metallic cable clips, cable ties or cable trunking as the sole means of support. Use fire-resistant means of support designed to prevent cables from falling into escape routes in the event of fire.

Segregate power and data wiring by spacing the systems apart where they run in parallel, containing power within screened cables or containment. Ensure that power and data cables cross each other at right angles.

Segregate the containment systems into the following categories, where possible:

- ~ 230/400 volt
- ~ extra-low voltage systems, IT systems, security systems
- ~ fire alarms

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For data processing applications, segregate cable terminals in distribution boards and /power distribution units.

Do not use junction boxes as part of the project work; except in situations where it is proven to be wholly unavoidable and only then with the acceptance of the Contract Administrator.

313 Mounting heights and accessory finishes

Be responsible for the layout of the final installed distribution boards/panels, allowing for all extension boxes, control devices etc for the complete installation.

As far as practically possible, ensure that all small power accessories are procured from the same manufacturer.

Comply with Approved Document M and specification section Y89.

Provide accessory finishes generally as follows, ensuring coordination between other accessories, eg lighting control switches, within these specific areas:

~ plant room: metal clad

314 Residual Current Device (RCD) protection

Provide RCD protection on power circuits to all socket-outlets up to 32 A rating to meet the requirements of BS 7671.

Provide RCD protection for all mobile equipment not exceeding 32 A rating for use outdoors.

Provide RCD protection to all cables concealed in a wall or partition where construction includes metallic parts other than fixings unless sufficient mechanical protection is provided as defined by BS 7671.

Provide mechanical protection / earthed conduit to all circuits as required by BS 7671.

Select the RCD and the electrical circuit it serves such that any protective conductor current that may be expected to occur during normal operation of the connected load will be unlikely to cause unnecessary tripping of the RCD.

Specifically consider the requirement of BS 7671 regarding the provision of RCDs, taking into account the following factors when designing circuits used for IT equipment:

- ~ high protective conductor currents in accordance with BS 7671
- ~ maximum number of appliances to prevent nuisance tripping when energising non-UPS circuits on load
- ~ cumulative neutral currents at common points of coupling, eg rising main busbars
- ~ means of isolation of equipment with multiple supplies
- ~ provision for extension of circuits into office furniture in accordance with BS 6396
- ~ segregated earthing arrangements if required by the brief
- ~ non-standard earth pins on computer power outlets particularly if UPS supported

Provide protection at distribution boards in the form of composite MCB/RCDs (RCBOs) with a maximum tripping current rating of 30 mA.

315 Surge Protection Device (SPD)

Provide SPD protection in the locations indicated on the distribution boards. Ensure that the device installed is the correct Type (1,2 or 3), rating and the installation method is in accordance with the manufacturers requirements

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Ensure that the internal wiring of the distribution boards is such that the protected wires do not run near the unprotected wires,

Ensure that the SPD devices are individually protected with an overcurrent protection device. The protection device must be selected according to the SPD manufacturers recommendations.

316 Supplies and connections to equipment

Provide low voltage dedicated power supplies for the following ancillary equipment from local sub-mains switch panels and/or LV distribution boards:

- ~ fire detection and alarm systems
- ~ security systems
- ~ electric heaters
- ~ fixed network components of automatic control systems
- ~ alarm and indication panels

Wire and connect all items of fixed equipment to a permanent supply, and not into the general service or computer sockets unless otherwise specified.

Provide surface- or flush-mounted switched fused connection units and/or isolators for ancillary equipment. Provide circuit wiring installed in a system of dedicated containment throughout its length.

Connect and functionally test all items of equipment supplied and installed under this contract.

Liaise with other suppliers or installers to ensure the equipment is fully operational and safe.

320 Area-specific requirements

321 Plant rooms/ancillary buildings

Provide low voltage power socket outlet installations within the plant room, roof spaces and ancillary building, to provide power services for maintenance purposes within the areas, along with supplies to ancillary equipment.

Mount socket outlets on walls around the perimeter of the plant areas or on columns as appropriate, served from local power distribution boards. Use metal clad sockets and accessories.

Supply and install sub-main power supplies and carry out final terminations to all mechanical plant and automatic control interface (ACI) enclosures.

Provide power supplies to high sensitivity smoke detection (HSSD) panels, building management system (BMS) outstations etc via dedicated switched fused connection units complete with neon indicators.

Provide power supply to life safety equipment (eg smoke vent panels, fire alarm panels, BMS outstations etc) via appropriately protected and fire-resistant cable systems.

322 IT equipment cabinet power supplies

Provide power supplies to the IT equipment from the local distribution boards as shown on the schematic drawings and layout drawings.

330 External systems supplies

Provide electrical supplies including distribution switchgear, distribution boards, feeder pillars, main cables and façade distribution systems to the following external systems:

- ~ flood lighting
- ~ external features

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- ~ pumping stations
- ~ site service road lighting
- ~ barriers/gates
- ~ trading power sockets

400 CONTROL REQUIREMENTS

410 Circuit control

Provide each final circuit with a protective device to allow automatic disconnection of the supply in the event of a downstream fault. This device may also act as a means of manually isolating the circuit. Provide a means of locking-off this device.

Select protective devices to suit the load characteristics and the prospective short-circuit current. Use one or more of the following devices:

- ~ Fuses conforming to BS EN 60269
- ~ MCCBs conforming to BS EN 60947-2
- ~ MCBs conforming to BS EN 60898, Type B, C or D, or BS EN 60947-2 as appropriate; minimum fault rating 9 kA
- ~ RCDs – either combined with MCB, or protecting part or whole of a distribution board, or located at the load; 30 mA sensitivity

420 Local isolation

Provide local isolation of each LV power supply integral to an outlet or local to equipment positions by:

- ~ unplugging
- ~ fuse removal
- ~ isolating switch
- ~ isolator
- ~ isolating switch breaking remote control circuit only if the installer complies with BS EN 60947-3 and is suitable and marked with the symbol for isolation.

Refer to BS 7671 for a full schedule of devices.

500 SCOPE OF WORKS

510 Responsibilities

520 Detail coordination

Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.

Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

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600 SYSTEM COMPONENTS

610 Standard 13 amp socket outlets and fused connection units

Provide low voltage power socket outlet installations for general service throughout the building. Install twin / single-gang, BS 1363, 13 A switched socket outlets for tasks such as cleaning and maintenance, wall-mounted such that:

- ~ no area is more than 10 m from a socket outlet
- ~ socket outlets are spaced at not more than 15 m centres along a wall

Fit socket outlets and connection units into a back-box of sufficient depth to prevent damage to wiring tails.

Connect each socket outlet and fused connection unit on the ring or radial principle. Do not spur off ring circuits.

Configure fused connection units and flexible cable outlets as indicated on layout drawings, or as appropriate to the design intent, from the following options:

- ~ switched / unswitched
- ~ with or without neon indicator
- ~ flex outlet through faceplate
- ~ flex outlet at remote plate
- ~ remote outlet directly behind wall mounted equipment

Connect to equipment with white-coloured three-core flexible cable. Use heat-resisting cable with minimum 85°C rating insulated conductors, and provide a fixed base terminal block in the outlet plate box if it is located more than 2 m from the fused connection unit.

For direct fixed wiring connections into equipment use heat-resisting cable with minimum 85°C rating insulated single-core LSF cables between the terminals of the connection unit and the equipment terminals. Do not introduce unnecessary terminal blocks.

620 Isolating switches

In plant rooms and other areas with surface-mounted installations, use surface-mounting cover plates with metal clad finish.

Fit isolating switches into a back-box of sufficient depth to prevent damage to wiring tails.

Connect each isolating switch on the ring or radial principle. Do not spur off ring circuits.

Connect to equipment with white-coloured three-core flexible cable. Use heat-resisting cable with minimum 85°C rating insulated conductors, and provide a fixed base terminal block in outlet plate box if it is located more than 2 m from the isolating switch.

For direct fixed wiring connections into equipment use heat-resisting with minimum 85°C rating insulated single-core LSF cables between the terminals of the isolating switch and the equipment terminals. Do not introduce unnecessary terminal blocks.

630 Isolators

Provide isolators for three-phase power supplies to equipment within the building.

Generally, make final connections to the items of equipment with rigid steel conduit installed surface, to a position adjacent to the equipment terminal box terminating in a standard conduit box with fixed connector block. Make final connections to the equipment with multicore heat-resistant cable enclosed in flexible conduit, terminating directly on to the terminal box of the equipment.

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Fit a label to the front cover of each isolator. Use melamine identification labels, having a white background with 3.5 mm high uppercase black engraved lettering, to identify the item of equipment served.

640 Industrial plugs and socket outlets

Provide surface-mounted industrial plugs and sockets outlets.

Connect each socket outlet on the radial principle.

Configure socket outlets as indicated on layout drawings, or as appropriate to the design intent, from the following options:

- ~ switched / unswitched
- ~ with or without neon indicator
- ~ minimum IP44 ingress protection rating (indoor use)
- ~ minimum IP67 ingress protection rating (outdoor use)

Use heat-resisting cable with minimum 85°C rating insulated conductors and provide a fixed base terminal block in outlet plate box if it is located more than 2 m from the isolator.

For direct fixed wiring connections into equipment use heat-resisting cable of minimum 85°C rating insulated single-core LSF cables between the terminals of the isolator and the equipment terminals. Do not introduce unnecessary terminal blocks.

650

700 FIXING TO BUILDING 'FABRIC'

Comply with specification section Y90.

800 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with specification section Y82.

900 TESTING AND COMMISSIONING

910 General

Upon completion of the installation, carry out an NICEIC / ECA electrical certification of all distribution boards and final circuits complete with 100% circuits labelling accordingly.

Comply with specification section Y81.

920 Testing and commissioning of specialist medical equipment and power supplies

Ensure all specialist equipment is fully works-tested prior to installation and is provided with works test certificates for inclusion in the operating and maintenance instruction manuals.

Provide full electrical and mechanical (where necessary) test certification from the various specialist suppliers/installers as detailed in this section of the specification. Issue the certificates prior to energising any specialist equipment, in certain instances energisation will only be permitted upon receipt of relevant test certificates by the specialist supplier/installer.

Ensure that CAD record drawings of the installation and associated controls are completed and available on site to specialist equipment suppliers / manufacturers prior to commencing commissioning.

Prepare a method statement for the tests, stating how they are to be undertaken.

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Prepare a schedule of tests to be applied to the system to demonstrate correct operation of the installation.

Perform a visual inspection of the whole installation covering equipment and cable to verify:

- ~ compliance with Health Technical Memoranda (HTMs)
- ~ compliance with all other applicable British Standards
- ~ correctly selected and erected equipment in accordance with BS 7671
- ~ no visible damage so as to impair safety
- ~ correctly installation and labelling
- ~ freedom from defects

Test the system in accordance with the method statement and record the results.

Arrange a mutually agreed programme for the above demonstrations with the Contract Administrator, providing at least ten working days' notice.

Fully demonstrate the complete operation of the installation to the satisfaction of the Contract Administrator and Client's representative.

Provide full test results of all electrical power systems in accordance with BS 7671 and issue a record of all tests with the operating and maintenance instruction manuals.

In addition to the above provide full equipment interface schematic diagrams detailing all equipment references, terminal numbers, cable types and core numbers (where applicable) for inclusion in the record drawings. Include both paper and latest version AutoCAD copies of all drawings within the operating and maintenance instruction manuals.

1000 SCHEDULE OF INSTALLER'S SUBMISSIONS

1010 Submittals with Tender

1020 Submittals during Contract

Submit the following for the Contract Administrator's comment:

- ~ Small power system samples as follows:
- ~ manufacturer's technical submissions for all items of equipment and associated components:
- ~ manufacturer's design and installation drawings
- ~ installation and commissioning programme
- ~ installation method statements and proposals for the supply and installation of all equipment
- ~ inspection details and certificates
- ~ operating and maintenance manuals for all items of installed components and equipment
- ~ record drawings
- ~ completion certificate(s)
- ~ test and commissioning certificates

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END OF SECTION V22

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V40 EMERGENCY LIGHTING

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V40 EMERGENCY LIGHTING

100 PERFORMANCE OBJECTIVES

The intention of the system is to provide sufficient illumination to allow people to evacuate a building safely when the normal lighting has failed in an emergency situation.

To provide throughout all areas, including external escape routes and open areas, as detailed on the drawings and in the specification, a complete emergency lighting installation to allow safe egress from the building and provide anti-panic lighting in the event of circuit(s) failure or total mains failure.

To provide emergency lighting in areas where the use of the space creates an inherent hazard to safe and easy escape.

To provide an emergency lighting system that clearly and unambiguously indicates all escape routes, internally and externally as required; and provides illumination along such routes and the immediate external areas of escape routes, so as to allow safe movement towards and through all exits.

To provide emergency lighting coverage to all fire alarm call-points and fire-fighting equipment provided along escape routes in order they can be located when the normal lighting has failed.

To provide escape route directional signs, where a direct line of sight to an exit is not possible, to direct persons towards a final escape exit.

200 DESIGN PARAMETERS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

Health & Safety at Work Act

BS 764	Specification for automatic change-over contactors for emergency lighting systems
BS 5266	Emergency lighting
BS 5499-4	Safety signs. Code of practice for escape route signing
BS 6290	Lead-acid stationary cells and batteries
BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
BS 6972	Specification for general requirements for luminaire supporting couplers for domestic, light industrial and commercial use
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 7846	Electric cables. Thermosetting insulated, armoured, fire-resistant cables of rated voltage 600/1000 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification

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V40 EMERGENCY LIGHTING

BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with a 930° flame and with water spray
BS 8592	Electric cables. Thermosetting insulated, non-armoured, fire-resistant, single core non-sheathed cables of rated voltage 450/750 V, having low emission of smoke and corrosive gases when affected by fire. Specification
BS EN 1838	Lighting applications. Emergency lighting
BS EN 13032-3	Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for emergency lighting of work places
BS EN 50171	Central power supply systems
BS EN 50172	Emergency escape lighting systems
BS EN 50200	Method of test for resistance to fire of unprotected small cables for use in emergency circuits
BS EN 60079	Explosive atmospheres
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60598-2-22	Luminaires Particular Requirements. Luminaires for emergency lighting
BS EN 60622	Secondary cells and batteries containing alkaline or other non-acid electrolytes. Sealed nickel-cadmium prismatic rechargeable single cells
BS EN 60896-11	Stationary lead-acid batteries. General requirements and methods of test. Vented types. General requirements and methods of tests
BS EN 61347-2-7	Lamp controlgear. Particular requirements for battery supplied electronic controlgear for emergency lighting (self-contained)
BS EN 61951	Secondary cells and batteries containing alkaline or other non-acid electrolytes. Portable sealed rechargeable single cells
BS EN 62034	Automatic test systems for battery powered emergency escape lighting
BS EN 62386-202	Digital addressable lighting interface. Particular requirements for control gear. Self-contained emergency lighting (device type 1)
BS EN 62733	Programmable components in electronic control gear. General and safety requirements
BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs
BS ISO 3864-1	Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings
ICEL 1001	Scheme of product and authenticated photometric data registration for emergency luminaires and conversion modules
ICEL 1004	Requirements for the re-engineering of luminaires for emergency lighting use
CIBSE Lighting Guides and Codes	

For the purpose of this specification the following emergency luminaire definitions apply:

i) **Defined escape route lighting**

This enables the safe exit by the occupants from buildings and immediate external areas by providing them with appropriate visual conditions and direction-finding on escape routes and special locations. It ensures that the fire alarm call-points, fire-fighting equipment and safety equipment can be located and used.

Design standard: 1 lux (min), operation in 5 seconds.

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V40 EMERGENCY LIGHTING

ii) **Open area (anti-panic area) lighting**

This is provided to reduce the chances of panic and enable the building occupants to move safely towards exit routes by providing them with appropriate visual conditions and direction-finding.

Design standard: 0.5 lux (min), to defined areas, which excludes a border of 0.5m, operation in 5 seconds.

iii) **Specific locations lighting**

Emergency illumination in specific positions to enable normal activities to be terminated safely.

- Plant rooms, switch rooms and emergency winding facilities for lifts - 15 lux (min), operation in 5 seconds.
- Fire alarm control and indicating equipment - 15 lux (min), operation in 5 seconds.

300 **SYSTEM DESCRIPTION**

310 **General**

Supply and install the complete emergency lighting installation including all wiring, manual and automatic controls, luminaires, lamps and emergency supply equipment as detailed on the drawings, in this specification and in the equipment schedules.

Ensure that all luminaires notated as emergency are Industry Committee on Emergency Lighting (ICEL) approved whether detailed in the schedule of luminaires or not.

Ensure the emergency lighting system provides the following coverage:

1. Illumination of all defined escape routes within the building
2. Illumination of escape route immediately adjacent to the building
3. Illumination of defined external escape routes- identify
4. Illumination of specific areas- identify
5. Illumination of open areas
6. Illumination of high risk task areas – identify

For the purposes of this specification the following emergency luminaire definitions apply:

Non-maintained – luminaire in which the emergency lighting lamps are only in operation when the supply to the normal lighting fails

Maintained – luminaire in which emergency lighting lamps are energized at all times when normal or emergency lighting is required

Combined – luminaire containing two or more lamps, at least one of which is energised from the emergency lighting supply and the others from the normal lighting supply. A combined luminaire is either maintained or non-maintained

Standby lighting - that part of emergency lighting provided to enable normal activities to continue substantially unchanged

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V40 EMERGENCY LIGHTING

Provide an emergency lighting system, classified in accordance with BS EN 60598-2-22 Annex B comprising:

Provide an emergency lighting system, classified in accordance with BS EN 60598-2-22 Annex B comprising:

Self-contained luminaires	X	0	XXXX	180
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Maintained illuminated exit signage operation	X	1	XXXX	180
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Ensure the minimum duration in emergency mode is not less than 180 minutes.

Provide the facility for periodic testing via local test switches.

Ensure that the emergency lighting system is supplied and installed complete with lamps and control gear, and emergency supply as detailed in this section to form a compliant, complete and fully functioning emergency lighting system.

Co-ordinate the complete system installation, including planning cable routes, access requirements and equipment locations, to provide a neat and tidy installation.

Ensure that the emergency lighting installation is independent of all other systems' wiring in accordance with BS 7671 and as set out in this specification.

In plant rooms and external to buildings, except in hazardous areas, ensure the installation is surface-mounted in galvanised conduit or designated cable types together with metal-clad accessories. In hazardous areas, install appropriate services commensurate with the hazard.

Refer to the layout drawings and this specification for wiring types, system operation, location of emergency lighting test switches, and automatic testing and monitoring systems.

Provide during the course of the contract works, samples of luminaires with the choice of louvres and lamp types for demonstration and final selection at site, generally in line with the Schedule of Luminaires.

Where alternative luminaires to those listed in the Schedule of Luminaires are proposed, provide full design calculations for the emergency lighting installation to all affected areas including an assessment of any load adjustment to the central battery system and associated electrical distribution system (where applicable).

320 Luminaires

Provide luminaires as specified in the Schedule of Luminaires.

Equip LED emergency luminaires with a combined converter/interface module for operation and communication.

Provide emergency lighting luminaires complete with EC Directive 92/58/EEC or BS ISO 3864-1 and BS EN ISO 7010 standard exit legend (running man) at designated exit doors and changes in direction, as agreed with the relevant authorities.

330 Self-contained systems

Unless specified otherwise use only luminaires whose emergency output duration under emergency conditions is 3 hours.

Provide self-contained luminaires:

1. contained as part of normal use luminaires forming part of the general lighting installation

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V40 EMERGENCY LIGHTING

2. in the form of emergency exit signs

400 CONTROL REQUIREMENTS

410 Self-contained systems

Ensure that self-contained luminaires automatically switch over to their secondary supply on failure of the primary unswitched supply.

Ensure that upon return of the unswitched supply the luminaire automatically switches back to the primary supply and recharges the battery.

Except where the design of the lighting control system includes the function to initiate an 'Emergency lighting test mode', prevent the lighting control system from effecting the operation and charging of the emergency lighting system. Do not dim circuits feeding battery chargers.

420 Periodic testing

Install the emergency lighting to enable testing by via local key-switch controls suitably ganged as set out on the layout drawings.

Unless specified otherwise, provide emergency lighting key-operated test switches, local, wired to break the circuit live supply to switch off the normal lighting luminaires and operate the emergency lighting luminaires for test. Ensure that the test switches are suitably engraved to indicate their function.

500 SCOPE OF WORKS

510 Responsibilities

520 Detail co-ordination

Agree with the Contract Administrator all proposed methods of fixing the system(s) to structure.

Agree with the Contract Administrator the colours and finishes of all exposed materials of the system(s).

Positions shown on the drawings of luminaires within plant areas and risers are provisional only. Co-ordinate the exact locations of these with the mechanical installer at the outset of the contract Works.

600 SYSTEM COMPONENTS

610 General

Install the system according to BS 5266, the appropriate product standards, and manufacturer's guidance.

611 Hazardous areas

Where the layout drawings identify areas that have particular requirements for electrical apparatus and installation practice, comply with BS EN 60079 and any other associated standards or applicable guidelines/statutory instruments.

612 Damp, corrosive or underground locations

Where emergency lighting circuits are installed in locations or atmospheres that are wet, damp, or contaminated by corrosive solids, liquids or gases, provide protection against such conditions for cables by means of a suitable sheath.

Where a suitable sheath cannot be installed provide equivalent protection by over-wrapping or alternative containment.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V40 EMERGENCY LIGHTING

613 Protection against physical damage in arduous conditions

Where emergency lighting circuits are installed in conditions where physical damage is likely, provide additional robust mechanical protection.

Examples of such conditions include:

- a) where impact by road vehicles, fork lift trucks, hand carts, etc is likely; or
- b) where damage by people or conveyor machinery carrying unsteady goods might be likely; or
- c) where damage might occur from ladders/plant for maintenance of adjacent equipment.

Where cables are to be installed in locations where they might be subjected to low temperatures, eg high roof locations, cold/freezer rooms etc, use only cables constructed to withstand the particular operating temperature(s), installed in accordance with the manufacturer's instructions.

620 Luminaires

621 General

Supply and install all luminaires for emergency lighting systems complete with diffusers, reflectors, lamps, control gear and necessary support and fixing brackets etc in the positions indicated on the drawings, as detailed in the Schedule of Luminaires, and in accordance with specification section Y73.

630 Self-contained luminaires

Install local self-contained 3-hour duration maintained battery/inverter units to provide a secondary power source to illuminate lamps of luminaires at a reduced output in the locations indicated on the layout drawings.

Provide the units complete with self-contained sealed Lithium-ion batteries, inverter and changeover module housed within the body of the luminaire or within a separate proprietary sheet steel ventilated box type enclosure fixed to the rear of the respective luminaire.

Ensure that each luminaire/unit is complete with indicating LED to indicate the correct operation of the emergency lighting system.

Ensure that the luminaires are factory-converted by the emergency lighting/luminaire manufacturer to ensure correct operation and compliance with all other relevant standards.

640 Lamps

Supply and install all lamps for luminaires as detailed in the Schedule of Luminaires and in specification section Y73.

Ensure all luminaires are complete with matched lamp and ballast/control gear.

Ensure all luminaires operate within the operating voltage range as set out in the European Standard at a nominal voltage of 230V.

Ensure that there is no striation of lamps present in any operating conditions on mains or battery.

650 Switches

Supply and install all lighting switches, key switches and, where specified, control contactors, for emergency lighting system testing, in the positions as indicated on the layout drawings, and connect to the lighting final sub-circuit, also as indicated on the layout drawings and in accordance with the distribution board schedules.

Provide accessories from the same manufacturer and with the same finishes as detailed in section V22 of this specification.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

V40 EMERGENCY LIGHTING

Ensure that the cover plates are suitably engraved to indicate their function. Ensure that operation of the emergency lighting test switch switches off the normal circuit live supply and operates the respective emergency lighting luminaires for test.

660 Wiring

661 Wiring for self-contained systems

Supply and install emergency lighting final circuit wiring to the same standard as the normal luminaires.

700 EQUIPMENT

710 General

Install the system according to BS 5266, the appropriate product standards, and manufacturer's guidance.

800 FIXING TO BUILDING FABRIC

Comply with specification section Y90.

When fixing accessories to the structural steelwork, use proprietary brackets or clamps. Do not drill or weld to the structural steelwork.

When installing luminaires within grid ceilings, ensure that the ceiling contractor is aware of the lighting installation to ensure that the ceiling support provision (type and frequency) is suitable.

900 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with specification section Y82.

1000 TESTING AND COMMISSIONING

1010 Tests

Fully test and commission the complete system at Practical Completion and provide all test results and printouts for inclusion in operating and maintenance instruction manuals.

Carry out testing including operational and system duration tests.

Operate the test functions for the emergency lighting and verify satisfactory operation of the test facility and of the emergency lighting.

At such positions and quantum as agreed with the engineer, take suitable measurements of the illuminance level at the initiation of the changeover to emergency lighting and at the end of the rated duration of the system. Record these measurements accurately upon record drawings and present to the Contract Administrator for comment.

Verify that all batteries are in a condition of charging prior to and after duration tests. Prior to duration tests, ensure the batteries are fully charged.

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MANCHESTER ROYAL INFIRMARY

V40 EMERGENCY LIGHTING

1020 Documentation

Complete and provide the design, installation and verification declarations, system certification and log book to the Contract Administrator and include copies in the operating and maintenance instruction manuals.

Comply fully with the requirements of BS 5266-1 and annexes in respect of ensuring sufficient information is provided upon the testing, commissioning and completion certificates.

Ensure the emergency lighting system log book is compliant with BS 5266-1, BS 5266-8 and annexes thereof.

1030 System instruction

Instruct the Employer's representatives on the operation of the system.

Include a practical demonstration of the installation and equipment. Arrange the required demonstration and agree the times and dates with regard to the overall contract programme works.

Ensure that the operating and maintenance instruction manuals and record drawings are made available prior to the Employer's demonstration and instruction.

1100 SCHEDULE OF INSTALLER'S SUBMISSIONS

1110 Submittals with tender

- ~ schedule of proposed manufacturers for all items of equipment

1120 Submittals during contract

Submit the following to the Contract Administrator for comment:

- ~ selected manufacturer's design proposals
- ~ manufacturer's technical submissions and proposals for the supply and installation of all items of equipment and associated components
- ~ lighting system samples
- ~ lighting design input data and calculation output sheets
- ~ manufacturer's design and installation drawings
- ~ installation and commissioning programme
- ~ installation method statements
- ~ inspection details and certificates
- ~ completion certificate(s)
- ~ test and commissioning certificates
- ~ manufacturer's test certificates to verify compliance with Category TP(a) for luminaires specified with thermoplastic diffusers

END OF SECTION V40

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W30 INFORMATION TECHNOLOGY CABLING

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- 1060 Test notification
- 1070 Witnessing
- 1080 Test personnel
- 1090 Operations and maintenance manual
- 1100 WARRANTY
- 1200 SCHEDULE OF INSTALLER'S SUBMISSIONS

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W30 INFORMATION TECHNOLOGY CABLING

100 PERFORMANCE OBJECTIVES

Provide a complete structured cabling installation to support the data, video and ancillary systems installation.

Ensure that the performance of the cabling meets the following requirements:

- based on internationally recognised standards for design, performance and component type and quality.
- supports a wide range of current and future data and voice communications techniques with any outlet being able to be used for any service type.
- correctly structured and fully documented.
- has a minimum of a 25-year life, warranted by the manufacturer.

200 DESIGN PARAMETERS

210 Standards

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly, for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

BS 6701	Telecommunications equipment and telecommunications cabling - Specification for installation, operation and maintenance
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS 8492	Telecommunications equipment and telecommunications cabling - Code of practice for fire performance and protection
BS EN IEC 60332	Tests on electric and optical fibre cables under fire conditions - Test for vertical flame spread of vertically mounted bunched wires or cables - All Categories
BS EN 13501-6	Fire classification of construction products and building elements. Part 6: Classification using data from reaction to fire tests on power, control and communication cables
BS EN 50173	Information technology - Generic cabling systems
BS EN 50174	Information technology - Cabling installation
BS EN 50346	Information technology - Cabling installation - Testing of installed cabling
BS EN 50575	Power, control and communication cables - Cables for general applications in construction works subject to reaction to fire requirements
BS EN 60754	Test on gases evolved during combustion of materials from cables
BS EN 60793-1-1	Optical fibres Measurement methods and test procedures. General and guidance
BS EN 60794	Optical fibre cables (Full set)
BS EN 60950	Information technology equipment

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W30 INFORMATION TECHNOLOGY CABLING

BS EN 62949	Particular safety requirements for equipment to be connected to information and communication technology networks
ISO/IEC 11801	Information technology - Generic cabling for customer premises
TIA-568.2	Balanced Twisted-Pair Telecommunications Cabling and Components Standards

Ensure that the installed system complies with EMC requirements.

220 General

Provide a structured cabling installation comprising Category 6A cabling.

300 SYSTEM DESCRIPTION

310 Building description

The project involves the provision of structured cabling, for the Infrastructure Compound.

320 Communications Room

The building contains a Communication Room, in the location shown on the drawings, provided with a Comms Rack use for;

- termination of horizontal Category 6A cabling from RJ45 outlets.
- patching between backbone and horizontal cabling.
- accommodation of active network equipment e.g. core and edge Ethernet switches, firewall appliances, etc.
- patching between horizontal cabling and active network equipment.
- accommodation of servers and storage equipment.
- accommodation of UPS equipment.
- accommodation of security system equipment.

Agreement and confirmation required with Trust IT on the fibre connections locations from the existing IT network provided to the Infrastructure Compound Comms Rack.

330 General scope

Provide a structured cabling system for the distribution of voice, data, video, and other services, including horizontal cabling, outlet sockets, patch panels, etc. including but not be limited to the following:

- provision of equipment racks and cabinets

provision of copper cabling outlets, within the office area, utilising the raised floor using Grid Outlet Point (GOP) boxes and grommets / floor boxes / utilising dado trunking.

- cable, outlet and patch panel labels
- provision of patch leads and fly leads
- local earthing and bonding to equipment
- the provision of drawings, documents and computer records
- testing and commissioning of the cabling system

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W30 INFORMATION TECHNOLOGY CABLING

Source all cabling, outlets, patch panels, cable management and associated accessories from a single manufacturer.

400 CONTROL REQUIREMENTS

500 SCOPE OF WORKS

510 Responsibilities

The following associated works will be carried out separately from the structured cabling package. These works will include, but not be limited to:

- provision of containment from the telco riser to the MER/MCR (provided in the electrical services sub-contract package)
- provision of cable containment to support the structured cabling installation (provided in the electrical services sub-contract package) except flexible conduits to outlet presentation boxes and modules.
- installation of all wide area networking circuits
- installation of telephone systems
- installation of IPTV and audio-visual services
- installation of communications functional earthing system from building entry to equipment rooms
- installation of local area networking equipment
- all lighting, power, environmental services, fire alarm and detection, fire suppression and security systems
- UPS system
- Fire-stopping

520 Detail coordination

Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.

Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

600 SYSTEM COMPONENTS

610 General system architecture

Provide structured cabling that comprises a backbone and horizontal cabling infrastructure.

A schematic of the structured cabling infrastructure is included in the tender documents.

Supply and install select from list below cabling from the MER/MCR cabinet to terminate in RJ45 outlets in the approximate locations shown on the data layouts.

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W30 INFORMATION TECHNOLOGY CABLING

620 Backbone and horizontal cabling

Ensure that the Category 6 cabling adheres to the following specification:

Structured cabling to be: Brand rex / Leviton CAT6 23AWG U/UTP 4-pair cable IEC 1156-5 Green Euroclass CCA 305m. Final cable selection to be agreed with Trust IT

- minimum Class Cca-s1b,d2,a2 according to the requirements of BS 6701
- installed to the requirements of BS EN 50174
- all eight conductors in each cable connected to a single RJ45 socket at each outlet and in a patch panel
- twists in each UTP/FTP pair maintained to within 12mm of the termination at each outlet or in accordance with the manufacturer's requirements
- the outer sheath of the cable stripped back for the minimum distance necessary to terminate the cable
- numbering and colour coding of wire pairs as defined in ANSI/TIA-568 standards. Use the T568B wiring configuration throughout the installation

630 Outlets and installation

631 RJ45 outlets

Provide RJ45 outlets in each of the floor-, wall- and ceiling-mounted backboxes in the approximate locations shown on the drawings. Wire the RJ45 outlets with Category 6 cabling.

Ensure all RJ45 outlets conform to the requirement of Category 6 as defined by ANSI/TIA.

Ensure all RJ45 outlets are fitted with spring-loaded sliding shutters to prevent the ingress of dirt and dust.

632 Wall-mounted outlets

Provide RJ45 outlets in wall-mounted back-boxes provided under the electrical contract package.

633 Cable containment

Route cables via cable baskets and/or tray installed at high level in the general areas as indicated on the electrical containment drawings. Provide conduits from the main cable basket/trunking runs, to route cables to their termination points in back-boxes in the wall and ceiling.

Supply and install any required flexible conduits or cable socks.

With the exception of flexible conduits and cable socks, all cable containment comprising cable baskets, tray, trunking, rigid conduit, back-boxes, etc., complete with all accessories, will be provided under the electrical contract package. Refer to the electrical containment drawings and the electrical specification for details.

640 Cable installation

Ensure that cable ties secure all cables at intervals of not more than 600mm horizontally and not more than 300mm vertically. Use only the soft cable tie systems such as Velcro, to ensure maximum cable protection.

Ensure that where power and information technology cables are installed in parallel, the separation requirements detailed in BS EN 50174-2 are complied with.

Ensure that individual bundles of cable do not contain more than 24 cables.

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MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

Provide strain relief for all cables at their termination to patch panels or outlets, to avoid stress on individual conductors or fibre optic elements.

Take care to avoid kinking cables or bending them at sharp angles (i.e. less than the minimum bend radius for the cable).

Do not install cables on cable baskets/trunking to a depth greater than 75mm.

Install FTP/UTP cables with a minimum of 200mm slack in the cabinet in the form of a gooseneck, to allow for re-termination.

650 Cabinet

Provide 19" equipment cabinet in the MER/MCR to accommodate horizontal and backbone cabling terminations, patch panels, cabling accessories and active equipment.

Supply and install XXX No. 800mm wide x 1000mm deep x 42U high cabinets in the MER/MCR.

Ensure all patch cabinets are sourced from a single manufacturer.

Supply and install the required cabinets as shown on the drawings. Allow for 25% spare U capacity in the cabinets, to take into consideration future growth and to facilitate administration/servicing.

The layout of cabinets in the MER/MCR is shown on the drawings.

Bay patch cabinets together where cabinets are shown adjacent to each other.

Provide cabinets that comply with the following specification:

- Made from steel and painted.
- Fitted with 19" mounting frames positioned 150mm from front and 150mm from rear of cabinet
- Latching and lockable, perforated steel doors to provide airflow external to the rack (perforations providing a minimum of 50% free area). Provide each cabinet with a key to both the front and rear doors.
- Floor-standing cabinets mounted on a 100mm high plinth.
- Have provision for top and bottom entry of cabling with no sharp edges around the cable entry opening
- Low-noise heat extraction fans in the roof (limiting the noise level in the room to NR55).
- A 450mm slotted cable tray installed on both sides of each cabinet.
- Side infill strips with vertical cable management hoops/rings, of the largest size available for the cabinet, installed down the front of each cabinet.

Provide each floor-standing cabinet in the MER/MCR with two 12-way vertical rack-mounted PDUs installed at the rear of the cabinet. Ensure the PDUs are unswitched and equipped with a "power on" indicator lamp. Provide one PDU with IEC C13 sockets and an inlet plug suitable for the UPS. Provide the second PDU with IEC C13 sockets and a 16-amp commando plug. Refer to the schedules for detailed information.

Provide each cabinet with UPS units complete with network management cards. Install the UPS units at the bottom of each cabinet and configure them for network monitoring. Connect the outputs of the UPS units to the supply inlets of PDUs installed in the cabinet. Refer to the schedules for detailed information. Ensure all UPS units are sourced from a single manufacturer. Select the UPS to provide a minimum 30-minute battery autonomy at full load.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

Provide the cabinets with removable side panels. Remove the side panels where cabinets are bayed together. Retain the panels at the ends of each row of cabinets.

Ensure that each cabinet is fitted with earth continuity kit to enable all panels, doors etc. to be earthed in accordance with BS 7671 and BS EN 50174.

660 Cabinet installation

Ensure full-height cabinets are free-standing but not fixed to the floor.

Ensure cabinets are located as per the layout drawings.

Provide a minimum clearance of 1.2 m on all faces where access is required to the cabinets.

Connect each cabinet to a safety earth bar using a 10mm² green/yellow PVC-insulated earth conductor.

Provide earth bonding to the cabinets in accordance with BS 7671.

Provide a separate functional earth bar system for each cabinet to allow the clean earth bonding of equipment within each cabinet. Insulate the functional earth bar from the body of the cabinet and earth back to the main building earth bar provided under the electrical package.

Ensure the functional earth is segregated from the dirty earth.

Ensure that cabinets, patch panels etc. and the MER/MCR are properly cleaned and free of dust prior to handover.

Refer to the schedule and rack elevations for the list of active and passive equipment to be installed in the cabinets.

670 Patch panel layout

Provide horizontal cable management with hoops/rings between each patch panel and the patch panel adjacent to it, in the ratio of 1U of cable management for each 2U of patch panel.

680 FTP/UTP patching

Terminate Category 6 FTP/UTP horizontal and backbone cabling on 19" rack-mountable modules to the following specification:

- Presented as unshuttered RJ45 sockets
- Conforming to Category 6 requirements
- Density of 24 outlets per 1U of rack height
- Including provision for label strips above each row of connectors
- Equipped with cable management to facilitate cable routing to the rear of the panel
- Including a connection point for strain relief (tie wraps) for each cable.

690 Ancillary requirements

Carry out all the required patching in the MER/MCR and at user equipment/field devices on the floors.

Ensure that all patching is in accordance with a patching schedule agreed with the client.

Provide copper patch leads and fly leads that comply with the following:

- Four pair, non-stranded Category 6 UTP/FTP copper low smoke and fume fly leads and patch leads terminated in Category 6 compatible RJ45 connectors at each end of the cable

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

- Coloured grey, yellow, green, blue or red or other colours to be advised by the Contract Administrator.
- Each patch lead and fly lead individually packaged and accompanied by a test certificate to confirm conformance with the performance requirements and stating the Random Mating loss of each connector

Provide the required quantity of patch fly leads, calculated to ensure that 100% of the structured cabling elements have available leads.

Ensure client signoff is achieved on length and colour strategy, prior to the testing and commissioning.

700 EQUIPMENT

800 LABELLING

Provide labelling to identify all the components of the structured cabling installation.

Ensure all patch panels, cabinets, outlets, cables etc. are labelled using black lettering on a white background.

Provide typewritten cable labels that are the wrap-round, self-laminating types and are printed with the identifier for the cable.

Provide labels for outlets, patch panels and cabinets, that are made of traffolite or similar approved sandwich type material. Fasten the labels with a permanent adhesive or mechanical fixing.

Ensure that the labelling is in accordance with a labelling regime, which will be confirmed by the Contract Administrator. For the purposes of this tender, allow for a labelling scheme based on the format described below.

810 Label elements

The label type, location and format are described below and employ the following elements as required.

- <comms room> (comms room which an outlet is wired back to)

MER/MCR

- <cabinet ID> CAB1, CAB2, etc.
- <patch panel ID> U1, U2, etc. ('U' position of a patch panel within a cabinet)
- <port ID> 01, 02, etc. (port number on a FTP patch panel)
- <pair ID> 01, 02, etc. (port number (for fibre pair) on a fibre patch panel)
- <box ID> (identifier for floor, wall and ceiling boxes)
- F001, F002, etc. (for floor boxes)
- W001, W002, etc. (for wall boxes)
- C001, C002, etc. (for ceiling boxes)
- <outlet ID> A, B, etc. (for horizontal outlets)
- <cable type> C6 (for Category 6 FTP)

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

- <QTY> Quantity of cables or cable cores

820 Horizontal cable labels

Ensure all horizontal cables are labelled at both ends using the following label format:

- <cable type>/<outlet floor>/<box ID>/<outlet ID>/<comms room>/<cabinet ID>/<patch panel ID>/<port ID>

830 Horizontal outlet labels

Ensure that each outlet label is approximately 15mm x 5mm in size with engraved lettering.

Fix the label to the blanking plate or faceplate above the outlet.

Use the following format:

- <comms room>/<outlet floor>/<box ID>/<outlet ID>

840 Cabinet labels

Ensure that each cabinet is provided with two labels, fastened to the centre of the top of the front and rear of the cabinet frame.

Provide a label approximately 40mm x 40mm in size with engraved 9mm black lettering, in the following format:

- <comms room>/<cabinet ID>

Ensure that each patch field within each patch panel commences with a 1U blanking panel, labelled with the identity of the field that follows it.

900 FIXING TO BUILDING 'FABRIC'

Comply with Section Y90 of this specification.

1000 TESTING AND COMMISSIONING

1010 General

Ensure that the testing conforms to:

- test results are submitted in the tester manufacturer's format.
- full graph data is included in the results
- the tester is set to the correct cable characteristics as per the product's published specifications
- the latest tester software and firmware is installed
- the warranty is issued against the standard tested to (EN 50173 or other)

Test and commission all components of the structured cabling system.

Thoroughly test the cabling installation to confirm that the components and installation practices meet the defined standards.

Carry out all tests in accordance with an agreed methodology.

Maintain full records of all testing carried out and the results of the tests.

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MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

Provide paper and CD/DVD copies of the complete test results in the O&M manuals.

1020 Method statement

Provide a method statement to describe how the testing will be carried out.

Ensure that the statement includes the following:

- the procedures to be employed for carrying out the tests
- the format of test results produced by the test procedure
- the manufacturer, type and model of all test equipment to be used
- how the test results will be incorporated into the cable record/audit software package.

1030 FTP/UTP cable tests

Test all FTP/UTP cables, following installation, for:

- pair polarity
- crossed pairs
- continuity
- short circuits
- length
- attenuation
- cross-talk (near and far end)
- PS-NEXT
- ACRF
- PSACRF
- propagation delay
- delay skew.

Check the results against declared published results for the types of cable used.

Ensure each pair in each link is tested from both ends and the worst pair results used as the test result.

1040 Test equipment

Provide a valid calibration certificate, that is less than six months old, for each item of test equipment that is brought to site to measure performance data. Make the calibration certificate available for inspection on site.

Ensure FTP test equipment can provide accuracy for both channel and permanent link in accordance with the requirements of ANSI/TIA.

Ensure all fibre optic test equipment complies with BS EN 50174.

Ensure the light source and power meter pair provide attenuation accuracy better than 0.02dB.

Provide microscope(s), for inspection of terminated fibre optic connectors, that conform to the following:

- magnification of 200X minimum

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

- allow connection of LC connectors
- built-in front illumination
- built-in infra-red blocking filter.

1050 Test failures

Rectify each failure identified during testing by replacing the faulty cable or component.

If either in-line cable joints or flexibility points outside cabinets are detected during testing, replace the affected cable(s).

Remove all damaged cables and components from site.

1060 Test notification

Inform the Contract Administrator at least ten working days before commencing any tests.

Provide a programme for testing and agree the programme with the Contract Administrator and his agents.

1070 Witnessing

Offer for witnessing any testing requested by the Contract Administrator. The extent of the witness testing will be at the discretion of the Contract Administrator and could be all cables and components, or a random selection.

1080 Test personnel

Ensure that all personnel who carry out any testing are demonstrably qualified, either by experience or by training, for the test equipment to be employed.

Provide sample signatures for all authorised test signatories.

1090 Operations and maintenance manual

Provide an operation and maintenance (O&M) manual that details all the installed equipment and its operational requirements. The manual will be the reference document that will be used to assist with problem resolution.

Ensure that the O&M manual comprises the following as a minimum:

- 'As built' systems' overview
- Manufacturer's literature for the installed components (datasheets, etc.)
- Contact details (installer and manufacturer)
- Warranty details including warranty certificate
- 'As built' schematics
- 'As built' layouts
- 'As built' cabinet elevations
- 'As built' patching schedules
- Test results
- Detailed user guide and maintenance procedure

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W30 INFORMATION TECHNOLOGY CABLING

1100 WARRANTY

Ensure that the cabling installation carries a manufacturer's warranty for at least 25 years from the date of acceptance, for all permanent copper cabling, outlets, jacks, cabinets and cabinet equipment.

Provide a warranty that covers components and system performance, to the required standard for all elements of the cabling system.

Identify any exclusions from the warranty at tender stage. Any exclusions not declared at tender stage will not be accepted.

Describe the repair service, including reporting methods, repair times and escalation procedures in the warranty documentation.

1200 SCHEDULE OF INSTALLER'S SUBMISSIONS

Submit the following for the Contractor Administrator's comment:

Submit operating and maintenance instructions for all items of equipment including:

END OF SECTION W30

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MANCHESTER ROYAL INFIRMARY

W42 SURVEILLANCE SYSTEM

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W42 SURVEILLANCE SYSTEM

100 PERFORMANCE OBJECTIVES

To design, provide, install, commission, and demonstrate a video surveillance system designed for use in a professional security environment, which will allow an operator viewing images from standard resolution cameras to:

- ~ monitor the number, direction and speed of movement of people when a person's figure occupies 5% of the vertical dimension of the screen (more than 80 mm per pixel)
- ~ detect the presence of a person when the figure occupies 10% of the vertical dimension of the screen (more than 400 mm per pixel)
- ~ observe and distinguish some characteristic details of a person when the figure occupies 25% of the vertical dimension of the screen (more than 16 mm per pixel)
- ~ recognise a known person or determine that a person is not known when the figure occupies 50% of the vertical dimension of the screen; and (more than 8 mm per pixel)
- ~ identify a person beyond reasonable doubt when the figure occupies 100% of the vertical dimension of the screen (more than 4 mm per pixel)
- ~ inspect a person to enable characteristic details such as distinctive clothing to be seen when the figure occupies 400% of the vertical dimension of the screen (more than 1 mm per pixel)

Utilise the existing system that is IP-addressable and transmits all surveillance and control data signals over a standard Ethernet local area network (LAN).

To provide power over Ethernet to power all cameras.

200 DESIGN PARAMETERS

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Building Regulations

All data protection legislation

The Electromagnetic Compatibility Regulations

The Equality Act

BS 7671

Requirements for electrical installations. IET Wiring Regulations

BS EN 50132-5-1

Alarm systems. CCTV surveillance systems for use in security applications. Video transmission. General video transmission performance requirements

BS EN 60529

Degrees of protection provided by enclosures (IP code)

BS EN 61386

Conduit systems for cable management

BS EN 62676-1-1

Video surveillance systems for use in security applications. System requirements. General

BS EN 62676-4

Video surveillance systems for use in security applications. Application guidelines

ONVIF

Open Network Video Interface Forum (ONVIF) specifications and protocols

Ensure that the data storage is compatible with the requirements of the General Data Protection Regulations, the Data Protection Act 1998, and any replacement legislation.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W42 SURVEILLANCE SYSTEM

210 System requirements

Use a video surveillance system that is fully compliant with the requirements for a Grade 3 system as specified in BS EN 62676-4, except where these requirements are exceeded or modified in this specification.

300 SYSTEM DESCRIPTION

Ensure existing site-wide systems are of sufficient capacity to receive additional connections from the project. Upgrade / expand systems as required to provide required capacity, whilst maintaining operation of services on existing site.

Ensure the images from the CCTV cameras are made available at the sitewide security control room.

310 Camera locations

Provide CCTV as detailed on the layouts.

400 SCOPE OF WORKS

410 Responsibilities

The Electrical Installer will provide:

- ~ all electrical distribution boards
- ~ all power outlets and all cable and containment from the distribution boards to the outlets
- ~ all containment from the primary containment to the data outlets, including back boxes

The Information Technology (IT) Installer will provide:

- ~ the local area network (LAN)
- ~ all network switches
- ~ all data outlets
- ~ all network cables from network switches to the data outlets
- ~ all network equipment cabinets complete with power distribution and cable management

420 Security system installer's responsibilities

Employ a specialist Security System Installer registered with the National Security Inspectorate as a NSI Gold installer to design, install, test, commission and demonstrate the security systems. Ensure the Security System Installer has the necessary expertise and capacity to provide professional and timely maintenance and emergency repair services of all systems during the design life of the systems.

Provide all camera, camera movement, signal transmission, recording, display, monitoring and control hardware and software complete with licences.

Provide all enclosures, mounts, brackets and supports for all security equipment.

Provide all cable and containment from data and power outlets to all security equipment.

Provide all statutory warning signage.

Take responsibility for liaising with the Contract Administrator to agree on the positioning, colour and style of all visible parts of the installation before placing orders or commencing installation.

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W42 SURVEILLANCE SYSTEM

Take responsibility for liaising with all other trades, including the Main Contractor, Electrical Installer, IT Installer to coordinate the location and installation of all containment, cables, outlets, devices and equipment.

Take responsibility for ensuring that the selected equipment and installation locations meet all performance requirements and are fully compatible with the building elements on which it is installed.

500 SYSTEM FUNCTIONS

510 General

Utilise the existing sitewide video management software on servers and operator stations to perform all control functions simultaneously, including live viewing, retrieval, playback, exporting and system configuration, without affecting the performance of the system.

520 User interface

Utilise the existing site wide system, adding the cameras for the energy centre compound.

600 EQUIPMENT

610 Location

Install all visible equipment and devices in accordance with the architectural setting-out details.

Ensure that all central equipment, power outlets, data outlets and cables are installed in secure locations.

In each instance where outlets or cables cannot be installed in secure areas, take responsibility for obtaining written acceptance from the Contract Administrator to install such outlets or cables in non-secure locations before commencing the work. If acceptance is granted, install each cable in rigid galvanized steel conduit throughout its length and each outlet in a vandal-proof, lockable, secure box.

620 Cable and containment

621 Cables

Install all network cables between data outlets and security equipment. Use Cat 6 unshielded twisted pair (UTP) network cables.

Install all power cables between power outlets and security equipment.

622 Containment

Install all cables in rigid electrical conduit throughout its length. Ensure that all conduit is concealed in walls, floors or soffits, and that no cable or containment is visible after the works are complete.

Where multiple CCTV system cables run together within ceiling voids or vertically within service risers, install cables in horizontal or vertical cable basket or cable tray. Do not run power and data cables together in close proximity.

In each instance where containment cannot be concealed, take responsibility for obtaining written acceptance from the Contract Administrator to install the relevant cables in rigid surface-mounted galvanized steel or stainless steel conduit throughout its length before commencing any work.

Take responsibility for liaising with the Main Contractor, the Electrical Installer and the IT Installer to coordinate final location and installation methods of all containment.

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MANCHESTER ROYAL INFIRMARY

W42 SURVEILLANCE SYSTEM

630 Cameras

631 Camera specifications

Use cameras complying with the following minimum specification:

- ~ IP-addressable and compliant with the latest ONVIF standards
- ~ powered by power over Ethernet (PoE) via Cat 6 unshielded twisted pair (UTP) cable
- ~ H.264 video compression format

Where cameras require the use of ancillary heaters or fans for the control of condensation, provide separate mains power supplies to support these ancillary systems.

632 Camera types and mounting

In external areas, use weatherproof external cameras or enclosures designed for normal operation in environmental conditions of between -25°C and 60°C and between 20% and 95% relative humidity, with a minimum IP65 rating,

633 Intelligence

Use video motion detection (VMD) for all cameras.

Use electronic privacy masking of multiple user-defined areas for each camera's field of view.

634 Light sensitivity

Use cameras that produce clear colour video images without visible artefacts in all lighting levels, including low light conditions below 1 lux at 80% reflectivity and at an aperture setting of f1.2.

Use day/night external cameras that produce sharp focus images in all lighting conditions.

Include effective measures on each camera to ensure clear images of a target are produced when the target is viewed against strong backlight and to eliminate the effects of flare or silhouette. As a minimum, use wide dynamic range capability on all cameras.

635 Lenses

Use high optical quality glass lenses that provide sharp focus, accurate colour and distortion-free images across the entire image.

Equip each lens with an automatic iris.

Fit static cameras with a varifocal lens.

636 Enclosures

Manufacture dome bubbles and flat windows from optically pure, distortion free, impact-resistant polycarbonate or glass.

Limit the light attenuation factor of each dome bubble or flat window to no more than 1 f-stop.

Use vandal-resistant enclosures where mounted outdoors, and where shown on the drawings.

Equip external enclosures with an automatic heater or other provisions to stop condensation.

Equip flat window external cameras and enclosure with an operator controlled wiper.

641 Recording

Provide connection to the existing site server-based network video recorder (NVR) Monitoring and control.

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MANCHESTER ROYAL INFIRMARY

W42 SURVEILLANCE SYSTEM

637 System

Provide all monitoring and control equipment as specified or shown on the drawings, complete with all hardware and software, and designed for 24/7/365 operation in a professional security environment.

To be monitored from existing Main Security Control Room. Ensure existing equipment is of sufficient capacity to receive new camera feeds.

638 Operator stations

Coordination required with existing operator station to add the images for the project CCTV cameras.

Provide client software on all operator stations to allow remote monitoring, control and management of the security system via the graphic user interface.

640 Time and date

Provide a time and date generator to ensure that the time and date are accurate and identical on all parts of the system at all times.

Provide an automatic accuracy check and correction function to ensure the time and date remains accurate at all times, and that it automatically adjusts for official seasonal time adjustments and leap years.

Provide a means of easily checking and verifying the clock accuracy, suitable for use in legal proceedings in a court of law.

650 Uninterruptible power supply

Provide rack-mounted, online double conversion uninterruptible power supply (UPS) units to power all security equipment mounted in network equipment cabinets.

Ensure that each UPS unit provides 230-V 50-Hz power to all equipment at full load for a minimum of 15 minutes in the event of a mains power failure, to allow controlled shutdown of sensitive equipment.

Equip each UPS unit with an Ethernet port to allow status monitoring and alarm notification via the local area network. Provide all software to monitor the status and alarms of each UPS unit.

700 ELECTROMAGNETIC COMPATIBILITY (EMC) AND SCREENING

Ensure that all systems and equipment comply with all relevant EMC regulations.

Set up each camera to ensure that the image is not affected by any of the electrical or electronic equipment located near the camera.

800 SIGNAGE AND LABELLING

Fit bespoke surveillance warning signs in accordance with statutory and regulatory requirements. Design each sign in accordance with the Client's branding. Take responsibility for submitting a range of designs to the Client for consideration and for obtaining written acceptance of the signage before placing orders.

Ensure that no visible branding, text or graphics is applied to any cameras or other visible part of the installation, except the standard branding and technical information included during manufacture.

Take responsibility for liaising with the end user to determine the naming and numbering of each item of equipment mounted in network equipment cabinets and operator stations, and of each camera. Submit a schedule of numbers and proposed design of the labels to the end user for acceptance before commencing work.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W42 SURVEILLANCE SYSTEM

Fix an indelible printed label on each item of equipment in a discreet location.

900 TESTING AND COMMISSIONING

910 Procedures

Submit a detailed method statement of all testing procedures to the Contract Administrator for comment before testing commences.

Take responsibility for liaising with the end user to determine the naming, numbering and IP network address of each camera, server and recorder, and programme the system accordingly. Incorporate this information in the operation and maintenance documentation.

On completion, undertake full performance tests on the entire system as detailed in the testing procedure. Include as a minimum the following tests:

- ~ undertake a full electrical and connectivity test on the entire system
- ~ check that all alarm, fault and event triggers operate correctly, and that these triggers are communicated to the control system in real time
- ~ check that all equipment and cameras are correctly calibrated
- ~ check that all image masking, VMD and video analytics are correctly calibrated
- ~ measure all timed system actions, including pre- and post-recording, and record the results
- ~ test the operation of each UPS and record the duration of standby power supply
- ~ check that all parts of the installation display the correct time and date
- ~ Test the colour accuracy of the system by recording video images of a standard colour chart comparing the live and recorded images displayed on a computer monitor with the actual chart. Make all necessary adjustments to ensure accurate colour rendition and export the images to CD or DVD. Submit the CD or DVD to the Contract Administrator for comment.
- ~ Test the resolution of each camera by undertaking a Rotakin test. Record video images of each camera with the Rotakin test target positioned at the target location, and at such other locations required to produce the required test images. Export the recorded images to CD or DVD and view the images on a standard personal computer using standard video playing software. Check that lines at marking reference C on the target can be distinguished when the target is displayed at 100% of the vertical dimension of the screen and at 25 frames per second. Make any necessary corrections to the system and repeat the test until all cameras comply with the specification. Export all the compliant images to a CD or DVD. Submit the CD or DVD together with a certificate of compliance to the Contractor Administrator for comment.
- ~ ensure that the entire system satisfies all test results and produce a certificate of compliance to certify that this is the case
- ~ submit the certificate of compliance, the colour test results and the Rotakin test results to the Contract Administrator for comment before arranging a demonstration of the system
- ~ Test compatibility with existing system and control / viewing from Main Security Control Room.

Supply all test equipment required.

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W42 SURVEILLANCE SYSTEM

920 Demonstration

Demonstrate all functions to the Contract Administrator after all tests have been completed successfully, including but not limited to the following:

- ~ display and control of live images
- ~ search, retrieval and export of recorded images
- ~ colour accuracy of live and recorded images
- ~ operation of all software functions, video motion detection and video content analysis
- ~ the NVR operation is unaffected when the main power supply is disconnected
- ~ the system performance and image recording is unaffected when a hard drive is removed live from the hard drive array

Return to site one month after Practical Completion to prove the recording archive capacity.

1000 SCHEDULE OF INSTALLER'S SUBMISSIONS

1010 Submissions with tender

Submit with the tender the following documentation:

- ~ a copy of the Security System Installer's NSI Gold registration certificate

1020 Submissions during the contract

Submit for the Contract Administrator's comment:

- ~ technical details of all proposed equipment, devices and software
- ~ detailed schematic drawings of the proposed installation
- ~ full working drawings of all cable and containment routes coordinated with all the other trade packages
- ~ a certificate of compliance that all tests have been completed successfully and that all results comply with the specifications
- ~ full test results
- ~ a printed report of each camera view and details
- ~ explicit manufacturer's warranties for all equipment
- ~ complete operating and maintenance documentation

END OF SECTION W42

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

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PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

100 PERFORMANCE OBJECTIVES

Provide a fully automatic fire detection and alarm system to satisfy the area coverage, and operational and performance criteria as outlined elsewhere in this section. Ensure that the fire alarm system complies with the recommendations of BS 5839-1 for non-domestic premises.

Provide audible alarms and combined audible/visual alarms of the nature and type indicated, to achieve the required sound levels and intelligibility specified, and the remote information criteria, in compliance with all relevant British Standards.

Ensure all control and indicating equipment, standard power supply units and standard repeater units comply with the EMC requirements described in BS EN 54 part 2 and BS EN 54 part 4.

The fire alarm panel to be connected and interfaced with the existing site wide fire alarm system.

110 Fire protection system interfaces

Ensure that the fire detection and alarm system provides signals and interfaces with the operation of other fire protection systems and equipment including BMS.

200 DESIGN PARAMETERS

210 Reference documents

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

Electromagnetic Compatibility Regulations

Smoke Detectors Act

Approved Document B Fire Safety: Volume 2 – Buildings other than dwelling houses

Approved Document M Access to and use of buildings

BS 5446-2 Fire detection and fire alarm devices for dwellings. Specification for heat alarms

BS 5446-3 Fire detection and fire alarm devices for dwellings. Specification for smoke alarm kits for deaf and hard of hearing people

BS 5499-4 Safety signs. Code of practice for escape route signing

BS 5839-1 Fire detection and fire alarm systems for buildings. Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises

BS 5839-3 Fire detection and alarm systems for buildings. Specification for automatic release mechanisms for certain fire protection equipment

BS 5839-6 Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of fire detection and fire alarm systems in domestic premises

BS 5839-8 Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of voice alarm systems

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

BS 5839-9	Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems
BS 6266	Fire protection for electronic equipment installations. Code of practice
BS 6290-2	Lead-acid stationary cells and batteries. Specification for the high-performance Plante positive type
BS 6290-3	Lead-acid stationary cells and batteries. Specification for the flat positive plate type
BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
BS 7273-1	Code of practice for the operation of fire protection measures. Electrical actuation of gaseous total flooding extinguishing systems
BS 7273-3	Code of practice for the operation of fire protection measures. Electrical actuation of pre-action watermist and sprinkler systems
BS 7273-4	Code of practice for the operation of fire protection measures. Actuation of release mechanisms for doors
BS 7273-5	Code of practice for the operation of fire protection measures. Electrical actuation of watermist systems (except pre-action systems)
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant screened cables having low emission of smoke and corrosive gases when affected by fire. Multicore and multipair cables
BS 7671	Requirements for electrical installations. IET Wiring Regulations.
BS 7846	Electric cables. Thermosetting insulated, armoured, fire-resistant cables of rated voltage 600/1000 V, for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with a 930°C flame and with water spray
BS 8629	Code of practice for the design, installation, commissioning and maintenance of evacuation alert systems for use by fire and rescue services in buildings containing flats
BS EN 54-1	Fire detection and fire alarm systems. Introduction
BS EN 54-2	Fire detection and fire alarm systems. Control and indicating equipment
BS EN 54-3	Fire detection and fire alarm systems. Fire alarm devices. Sounders
BS EN 54-4	Fire detection and fire alarm systems. Power supply equipment
BS EN 54-11	Fire detection and fire alarm systems. Manual call points
BS EN 54-13	Fire detection and fire alarm systems. Compatibility and connectability assessment of system components
BS EN 54-18	Fire detection and fire alarm systems. Input/output devices
BS EN 54-21	Fire detection and fire alarm systems. Alarm transmission and fault warning routing equipment
BS EN 54-23	Fire detection and fire alarm systems. Fire alarm devices. Visual alarm devices
BS EN 54-25	Fire detection and fire alarm systems. Components using radio links

PROJECT RED ELECTRICAL INFRASTRUCTURE

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W50 FIRE DETECTION AND ALARM

BS EN 14604	Smoke alarm devices
BS EN 50200	Method of test for resistance to fire of unprotected small cables for use in emergency circuits
BS EN 50849	Sound systems for emergency purposes
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60896-11	Stationary lead-acid batteries. General requirements and methods of test. Vented types. General requirements and methods of tests
BS EN 60896-21	Stationary lead-acid batteries. Valve regulated types. Methods of test
BS ISO 7240-8	Fire detection and alarm systems. Point type fire detectors using a carbon monoxide sensor in combination with a heat sensor.
BS EN IEC 60079-0	Explosive atmospheres. Equipment. General requirements
BS EN IEC 62485-1	Safety requirements for secondary batteries and battery installations. General safety information
CIBSE	Guide E: Fire Safety Engineering
DoH HTM 05-03	Firecode – Fire safety in the NHS. Operational procedures Part B: Fire detection and alarm systems
FIA	Fire Industry Association. Code of Practice for Design, Installation, Commissioning & Maintenance of Aspirating Smoke Detector (ASD) Systems
Local Authority Standing Orders and Bylaws	
Loss Prevention Council publications	
British Approvals for Fire Equipment publications	

220 System parameters

Provide a non-domestic system to the following BS 5839-1 category of protection:

System Category (L):	L1
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Provide a system to the following arrangement:

Arrangement:	Conventional system
No. of detection zones (used):	To be determined by Contractor
No. of detection zones (spare):	20%

Arrangement:	Addressable system
Approx. no. of devices (used):	refer to layout drawings
No. of spare loop cards (for future use):	20%
Spare capacity per loop:	30%

Provide a system configured for the following alarm type:

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

Evacuation alarm type:	Single stage
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230 Status of Tender drawings

The fire detection and alarm system schematic and layout drawings are indicative only.

The position of all detectors, call points, visual alarm devices, and sounders / beacons are shown on the drawings for tender purposes only. At an early stage in the contract, determine the exact locations of all components on site and inform the Contract Administrator of any required position change(s) and obtain approval to such change(s) prior to installation.

300 SYSTEM DESCRIPTION

310 General

Fire alarm system is to be open protocol.

New fire alarm panel to connect to the existing site-wide system, using network cabling. Alerts are to be signalled on the site's head-end system.

New fire alarm panel located at;

- A Switchroom

All fire connection works must be carried out by the incumbent specialist contractor, unless agreed with Senior Capital Project Manager.

Ensure existing site-wide systems are of sufficient capacity to receive additional connections from the project. Upgrade / expand systems as required to provide required capacity, whilst maintaining operation of services on existing site.

Upgrades to the existing network and network cabling are required before commencement of the project.

Network cabling to be final cable selection to be agreed with Trust.

Repeater panels are to be configured to produce visual alarms only (no audible alarm) in the first instance.

The fire alarm panel within A Switchroom to be a fire brigade entry point (to be agreed)

Arrange for the fire detection and alarm system to include the following items:

- ~ main control and indication panel
- ~ automatic detection circuits or loops, connecting automatic detection devices, manual call points and other interface, isolation and control devices
- ~ status monitoring of all internal connections and interfaces including battery and remote signalling functions
- ~ discrete visual indications for all key functions
- ~ alarm circuits connected to audible, visual or combined alarms
- ~ auxiliary circuits connected so as to automatically interface with other systems, including gas shut-off valves

Ensure that call-points are of type A (direct operation) / B (indirect operation) to comply with BS EN 54-11 and all other components are to the relevant part/s of BS EN 54.

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

Provide all central control and indication equipment, and, where specified, distributed and repeat indication facilities.

Provide voice alarms to BS 5839-8, alarm devices for hearing impaired to BS 5389-1 and visual alarm devices to BS EN 54-23.

Provide software system and programming, including security of stored information; and re-programming capability. Ensure that all devices use open-protocol communications unless an alternative is agreed and accepted by the Contract Administrator.

Provide all system components from a single manufacturer's standard product range. Ensure that all components of the fire detection and alarm system are compatible and connectable to BS EN 54-13, and fully capable of delivering the requirements of this specification.

Do not use any equipment or components identified as end-of-line or otherwise not expected to have manufacturer continuing support and spares availability.

Ensure that all requirements of the chosen manufacturer's equipment are included for in the tender. Provide all ancillary components and items such as separate power supplies for bells, interface units, zone isolators etc. Provide for the manner in which the system is to be wired, which varies from one manufacturer to another. Determine the requirement for additional items by reference to architectural, mechanical and electrical drawings.

Arrange that the fire detection and alarm system is not susceptible to nor causes electromagnetic interference. Design and install the fire detection and alarm system such that it complies with the Electromagnetic Compatibility Regulations.

Provide all dwellings with smoke and carbon monoxide alarms to comply with The Smoke and Carbon Monoxide Alarm (England) Regulations.

311 Installer certification

Use a LPCB LPS 1014 (Requirements for certificated fire detection and alarm system firms) certificated firm for the design, installation / installation, and commissioning of the fire detection and alarm system specified herein. Ensure that the LPS 1014 certificated firm issues a signed LPS 1014 Certificate of Conformity in respect of the specified alarm system.

Use a BAFE scheme SP203-1 certificated firm for the design, installation/ installation, and commissioning of the fire detection and alarm system specified herein. Ensure that a BAFE certificated firm issues a signed BAFE SP203-1 Certificate of Compliance in respect of the specified alarm system.

320 System arrangement and detection

Ensure that all equipment connected to the fire detection and alarm system, either directly or via interfaces, is resistant to electrical noise and electromagnetic interference from other equipment.

Provide fire detection and alarm system of the following arrangement, or combination of arrangements.

321 Addressable system

Install and configure an addressable system in which all individual automatic detectors, manual call points, alarm devices and other field and interface devices have unique address identifications.

Use devices of the two-state type providing a 'fire' or 'normal' condition status.

Loop all detectors back to the main control and indicating panel. Ensure the control and indicating panel is microprocessor-based and pre-programmed with software that allows identification of both the condition and location of all devices in the system. Provide operating programs and configuration data capable of being updated.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

400 CONTROL REQUIREMENTS

410 System operation

Ensure that the fire detection and alarm systems can be used to:

- ~ initiate shutting down ventilation systems
- ~ initiate operation of fire suppression and smoke control systems
- ~ release passive control measures such as automatic closing fire doors
- ~ interface with voice alarm system
- ~ interface with disabled refuge alarm / emergency voice alarm systems
- ~ interface with gas shut-off valves

420 Control interfaces

421 Auxiliary systems control and mounting

Provide all necessary relay and termination facilities within the respective control and indication panels to achieve the requirements specified.

Ensure that the fire alarm system contains a sufficient number of volt-free contacts suitable for monitoring the fire protection interfaces listed in the Performance Objective (clause 100) section above.

Provide five spare volt-free contact sets for future connection.

Arrange for the other systems to initiate the appropriate action in the event of fire or fault signals being initiated, as indicated by the cause and effect schedule.

Ensure that the volt-free contacts are capable of switching the current and voltage of the auxiliary systems input.

Provide the following signals for monitoring to the BMS system:

- ~ main building fire alarm per zone / address
- ~ fire alarm control panels common fault
- ~ fire alarm system device fault

Wire all fire protection interfaces and BMS interfaces directly from the fire alarm panel, using cabling sized appropriately to the switching system operation requirements, and liaise fully with the specialist installers of those systems to effect satisfactory connections and operations.

Power all relays from the fire detection system supply.

Ensure that the interfaces with other systems do not prejudice the operation of the fire detection and alarm system at any time.

Ensure that routine testing of the fire detection and alarm system does not have any undesirable effect on other systems interfaced to it.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

500 SCOPE OF WORKS

510 Design development

Provide design development to installation level detail design of the fire detection and alarm system in accordance with this specification and drawings, including verification of the current information, and co-ordination with other Installers.

Provide a fire alarm cause and effect schedule based upon the project fire strategy.

520 Responsibilities

530 Detail co-ordination

Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.

Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

540 Existing system

Provide extensions and enhancements to, and reconfiguration of, the existing fire detection and alarm system, ensuring that all components provided are fully compatible with the existing system's operation including software protocol.

600 SYSTEM COMPONENTS

610 Installation, cables and wiring arrangement

611 Wiring arrangement

Provide the fire alarm system installation with a totally independent, separated, diverse and segregated wiring system in accordance with BS 5839-1 Paragraphs 24.2 and 26.2 and BS 7671. Ensure that the system uses the same cable type throughout, sourced from a single BASEC approved cable manufacturer. Ensure that the cable type is LPCB approved.

Connect all system equipment in circuit loop formation as indicated on the schematic drawing, in conjunction with the specialist fire alarm system manufacturer's recommendations.

Install sufficient short circuit isolation devices in each detector loop to ensure that a single fault does not disable more than 20 manual call points or sensors or one fire zone. Plan the installation of the detector cables accordingly.

Ensure that the maximum number of addresses allowed to be connected on each loop is not exceeded, and allows a minimum of 30% spare capacity.

Ensure that the routes of each "leg" of each loop cable are segregated from each other, in order to reduce loss of the entire fire alarm loop in the event of short- or open-circuit or earth fault occurring, and that only one cable "leg" can be affected by a fault.

Do not use four-core loop cables.

Wire sounder circuits using the 'A' and 'B' circuit technique to provide two separate circuits for any particular area and allocate sounders to the 'A' and 'B' circuits as indicated on the drawings.

612 Cables

Ensure that 'standard' fire resisting cables meet the BS EN 50200 PH 30 classification and the 30 min survival time when tested in accordance with Annex E of BS EN 50200.

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

Ensure that 'enhanced' fire resisting cables meet the BS EN 50200 PH 120 classification and the 120 min survival time when tested in accordance with BS 8434-2.

Provide all fire detection, alarm and signalling cabling using fire resistant cabling with red outer sheath.

Ensure that all cable sizing is in accordance with the manufacturer's recommendations subject to a minimum size of 1.5 mm² for detection / actuation circuits and 2.5 mm² for sounder circuits.

Install and terminate all cable in accordance with the manufacturer's recommendations.

Provide all cabling for the complete system in 600 / 1000 V mineral insulated copper sheathed (MICS) type. Ensure that the MICS cable and terminations comply with BS EN 60702. Ensure that the MICS cable is of the 'enhanced' fire resisting level.

Adhere to the material standards set down in the Y sections of this specification for the MICS wiring system.

Provide all cabling for the complete system in soft-skinned fire resistant cable rated at 300/500 V to BS 7629-1. Ensure that the soft-skinned cable is of the 'standard' / 'enhanced' fire resisting type.

Provide armoured fire resistant cables conforming to BS 7846 for the following locations: specify locations.

613 Installation

Ensure all cables are mechanically protected to BS 5839.

Install the cables to the FAS cable trays strictly in accordance with the manufacturer's instructions and recommendations and terminate using proprietary Type A2 brass glands or zero halogen low smoke polymeric red coloured glands. Use only zero halogen low smoke coated copper 'P' clips coloured red for direct fixing of cables. Use only fire-resistant cable ties, eg stainless steel, for fastening to the underside of cable trays or similar structures where support is required.

Install the cabling fixed to walls and on dedicated cable tray systems, to allow a practical means for future re-wiring of the system. Ensure all cable support is non-combustible and capable of withstanding an exposure to temperature at least equal to that of the supported cable. Fix cable supports and terminate cables in accordance with the recommendations of the cable manufacturer and in accordance with BS 7671.

Clip single or twin runs of cable in ceiling voids direct to the structure only where cable tray is not present. Provide cable trays where two or more cables follow a common route. Fix cable tray spaced off soffit by suitable galvanized brackets.

Adhere to the installation standards set down in the Y sections of this specification for the installation of the wiring system.

Earth all fire alarm system cabling in accordance with the requirements of BS 7671 and the recommendations of the manufacturer. Ensure that the electrical continuity of all electromagnetic screens is maintained throughout the system.

Install the wiring system concealed/flush other than in plant areas, including the final positioning and installation co-ordination of all system cabling and components together with the marking out of all associated builder's work.

Install all cables in a manner such that they are physically continuous throughout the length of each circuit other than where connection is made at the terminations of a system component. Do not use any other cable connections or joints.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

In all areas except plant areas, provide the final connections to all the system components via suitable conduit boxes fixed flush with the underside of the ceiling or flush in the wall. In plant areas, use a surface mounted installation.

Provide all necessary cabling from the main fire alarm panels to the appropriate mechanical control panels, lift control panels, etc, and liaise fully with the installers of those systems to affect satisfactory connections and operation. Either wire these services directly from the fire alarm panels, or utilise the appropriate detector/alarm circuit loops, via suitable interface units, if required. Size cabling appropriate to the switching system's operation requirements.

Make good all penetrations through walls, floors, partitions or ceilings with fire-stopping material.

620 Control and indicating control panel (analogue addressable / addressable)

621 General

Provide a microprocessor-based multi-zone, multi-loop main control panel of the analogue addressable/addressable type, housing all items of control and indication equipment and located and mounted as indicated on the drawings. Provide a panel with a fascia layout generally as set out in the selected manufacturer's standard arrangement and of tamper-proof construction. Mount the components on the front panel, or internally on a chassis.

Arrange the equipment mounting such that the enclosure can be fixed in position, and outgoing cables terminated, prior to the equipment being installed. Ensure the enclosure incorporates suitable internal cable management such that modular components can be easily replaced.

Arrange the internal layout to provide adequate free space for cable termination. Ensure access to all outgoing terminals is possible with the panel in an operational state. Provide access to terminals at the back of the enclosure by use of a hinged chassis, if necessary. Include a series of 20mm knockouts or gland plates at the top and bottom of the enclosure for the termination of cables.

Provide a zone plan, identifying the building fire alarm zones, at the main indicating panel and any repeat indicating panels. Mount the zone plan in a glass-fronted hardwood frame and fix adjacent to the panel.

622 Control function

Provide the panel with the following equipment as a minimum:

- ~ liquid crystal display, back-lit, providing up to 80 characters per alarm condition, to enable all alarm and fault conditions to be reported
- ~ display messages in English, with all information stored in the display memory to enable messages to be scrolled and reviewed prior to system re-setting
- ~ integral keypad for interrogation, programming, device labelling and device/zone isolation including facilities to display index, display log and review/scroll
- ~ all necessary control cards for the number of loops required, including spare capacity
- ~ lamp/LED indications
- ~ lamp/LED test key switches for fire, fire zone and zone fault/isolated
- ~ integral battery/charger power supply unit
- ~ an integral 24-column dot matrix printer to provide a hard copy of all information shown on the display, and stored information to provide history, full or selective, of system events
- ~ sufficient quantity of terminals to receive all incoming and outgoing circuit wiring, including provision for future spare capacity

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

- ~ at the main fire alarm system control panel, a key operated selector switch / software operated controls to inhibit shutdown of systems when carrying out routine sounder tests, or alternatively use a discreet code number entered via the control panel keypad for this function
- ~ output port to allow communication with a suitable computer, using either RS-232 or RS-485 data interchange system.
- ~ all necessary volt-free contacts to achieve operation of ancillary systems (as outlined at clause 110)

Where indicated by the drawings, provide the panel with a standard computer keyboard and interconnection facility in addition to the integral facility listed above.

Provide the panel with the following control functionality:

- ~ start sounders
- ~ test "Evacuate" alarm
- ~ stop sounders (alarm mute)
- ~ control clock and date setting
- ~ cancel fault buzzer
- ~ disable links to other systems for test purposes
- ~ panel test/enter
- ~ address isolate
- ~ change device type, add / remove devices, edit cause and effect
- ~ zone identification
- ~ two-stage alarm facilities
- ~ fault monitoring and fault indication for all internal connections and interfaces, including all detection circuits, to monitor and indicate short circuit and earth fault conditions, with a separate alarm output provided for each of these conditions
- ~ fault monitoring and fault indication for battery status, remote signalling status and top cover open, with a separate alarm output provided for each of these conditions
- ~ supervisory buzzer
- ~ real-time clock accurate to one minute per year and incorporating automatic daylight saving time adjustment
- ~ all necessary operating relay/switch devices and auxiliary devices to control remote ancillary devices
- ~ facilities for automatic remote dialling to a registered alarm centre network
- ~ alarm sounder circuits, of sufficient number as outlined elsewhere, complete with continuous circuit fault monitoring facilities
- ~ instructions for user operation

623 Construction

Provide all details of panel construction, layout and equipment for acceptance by the Contract Administrator prior to confirming instructions to the equipment manufacturer.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

624 Controls and indication

Equip the panel with all necessary controls and indication to monitor, interrogate, programme, silence, test and re-set the system.

Incorporate zone/address designation LED indicator boards, complete with full operating instructions and the facility to enter all zone and address allocations. Ensure that the panel is capable of indicating the exact source of the alarm condition on the display. Provide a non-volatile memory to record all system events, up to a maximum of 5000 events, and hold these available for printing out or displaying on screen. Record the time and date of each event with sufficient data to identify the device, zone and loop. Ensure that the earliest event is automatically discarded on memory overrun.

Provide power supply equipment that satisfies the requirements of BS EN 54-4 and BS 5839, with fault monitoring and fault indication for failure of main power supply, standby power supply, battery charger, and reduction of battery voltage.

625 Programming

Arrange for the initial programming to be completed by the manufacturer, including zone definition in accordance with BS 5839-1. Give each zone a unique reference. Make reference to the fire compartmentation to ensure that the zones chosen give compliance with British Standards requirements. Provide a marked-up drawing showing zone areas and hand to the Contract Administrator no less than 14 days before the system is offered for acceptance.

Carry out the necessary re-programming and configuration of the system without reliance on the system manufacturer. Ensure that the operation of the test feature is indicated on the fire alarm panel. Arrange that test procedures do not release any access controlled doors nor shut down any mechanical plant unless expressly instructed to do so as part of test.

626 Issue of information

Issue for comment, prior to programming, all necessary information, eg room names and numbers. Provide a full chart detailing device numbers, types, loop connected, zone, address and position as part of the user's operating and maintenance instruction manual.

627 Connection to repeat panels

Incorporate means for disabling the link to the repeat panel(s), with audible and visual indication when disabled. Provide audible and visual indication of disconnection or failure of remote links with the facility to manually mute audible alarms. Ensure that all alarm link controls are key operated.

630 Conventional control panels

640 Repeat indicator panels

Provide the number of repeat indicating panels in the designated locations as indicated elsewhere in the documents.

Provide repeat indicating panels that are self-contained, have their own mains and standby power supply, and provide immediate duplication of all indications displayed on the main control and indication panel. Ensure that the repeat panel(s) are identical in all regards to the main panel, with the exception that the repeat panel(s) do not have any control function facilities.

650 Field devices

651 General

Confirm all proposed device locations with the Contract Administrator and prepare installation drawings before commencing wiring or other equipment installation. Determine the full quantity of equipment, manual call-points, detectors, interface units, monitors, sounders etc, from layout drawings and specification requirements.

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

Keep detectors free of any contamination due to works taking place after installation and commissioning by bagging etc, and replace any detectors contaminated at no extra cost

Ensure that all field devices are labelled, in the field, with the device address, for easy identification. Ensure the field address is identical to that shown on the system drawings that form part of the completion documentation and is attached to the equipment so that if the device is removed for maintenance or replacement, the label is retained.

652 Mounting heights

Mount items of equipment at the following typical centre line heights above floor level (except where indicated otherwise on drawings):

- ~ manual call-points – 1200 mm
- ~ sounders in offices and other low ceiling rooms – 200 mm below soffit level
- ~ main control and repeat indicator panels – 1500 mm
- ~ beam detectors – minimum 3750 mm above finished floor level and maximum 300 mm below soffit level
- ~ visual alarm devices – minimum 2100 mm.

Agree all fire alarm equipment heights with the Contract Administrator prior to commencing installation and subject to architects' drawings which may be issued post tender.

660 Field devices

661 Detectors – general

Provide automatic detectors of the type and in the locations as indicated on the drawings and in accordance with BS 5839-1. Ensure each detector is of the analogue type and capable of being individually addressed.

Ensure all voids greater than 800mm are provided with void detection, including but not limited to: ceiling and floor voids, lift shafts, risers; in accordance with BS 5839-1

Agree the final location of detectors on site with the Contract Administrator and the specialist supplier.

Incorporate the following facilities in each detector:

- ~ common mounting base for different types, allowing detector heads to be fully interchangeable
- ~ integral LED alarm indication of operation where directly visible, with remote indication where concealed, ie duct sensors, lift shafts etc, labelled suitably.
- ~ capability of automatic or manual disablement for maintenance purposes
- ~ appropriate indication on main control and repeat panel when the sensor is removed from its base
- ~ ensure removal of the detector head does not render any part of system inoperative.

Ensure all automatic detectors produce an analogue output that changes with smoke density or temperature, and that detectors change this to digital data for transmission to the processor.

Ensure all automatic detection devices are individually compensated, at the master control panel, for any degradation in performance due to ageing, dust accumulation, component characteristic change etc.

Ensure that detectors installed anywhere on any loop are capable of being assigned to any zone.

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W50 FIRE DETECTION AND ALARM

662 Manual call-points

Provide manual call-points of the addressable type complying fully with BS EN 54-11, made of polycarbonate/moulded ABS material and finished in red. Ensure all manual call-points are of the same type. Install call-points complete with suitable inscription of operation and provided with suitable proprietary enclosures for surface or flush mounting within internal/external locations.

Incorporate the following facilities within each manual call-point:

- ~ external test facility to operate contacts without opening manual call-point
- ~ an LED to indicate operation of manual call-point
- ~ transparent safety covers to ensure that they are not operated inadvertently.

663 Automatic smoke detectors

Optical smoke detectors

Provide detectors of the obscuration or scatter light type, with sensitivity adjustment via the system control panel.

664 Isolation and interface devices

665 Audible alarm devices

Ensure all audible fire alarm devices conform to BS EN 54-3, and have similar and distinctive sound characteristics. Provide sufficient fire alarm sounders to ensure that sound pressure levels throughout all accessible levels of the building are in accordance with the recommendations of BS 5839-1.

Ensure all audible alarm devices and flashing beacons are loop powered and addressable.

Electronic sounders

Provide sounders with an output frequency of 500 to 1000 Hz, providing a sound pressure level of not less than 104 dBA at 1 metre and having an adjustable volume control. Ensure that the number of sounders on any one circuit does not exceed the manufacturer's recommended maximum.

Provide sounders that are electronic two-tone and red coloured. Ensure that sounders are polarised and suppressed as standard. Supply units complete with a centre disc bearing the legend "Fire" in black.

Ensure that the number of sounders for circuit A or circuit B does not exceed the current rating of the sounder circuit and allows for 20% spare capacity.

Flashing beacons

Provide flashing beacons to operate at all times whilst sounder circuits are activated. Do not incorporate mute or isolation switches.

Ensure flashing beacon units are electronic Xenon / LED and sensor-base mounted, wall-mounted and where necessary combined with audible alarm devices.

666 Visual alarm devices

Ensure that visual alarm devices conform to BS EN 54-23 and only use in conjunction with audible alarms.

Install visual alarm devices in accordance with BS 5839-1 and following the recommendations of the VAD manufacturer on the correct mounting height and orientation of VADs to ensure correct light dispersal and coverage.

Comply with the recommendations of the Loss Prevention Council Code of Practice CoP 0001 Issue 1.0 'Code of Practice for visual alarm devices used for fire warning'.

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W50 FIRE DETECTION AND ALARM

Arrange that the visual alarm device flashes at a rate between 30-120 flashes per minute.

670 Other field devices

671 Field devices for addressable systems

672 Field devices for conventional systems

673 Intrinsically safe field devices for hazardous areas

700 EQUIPMENT

710 Power supplies

711 General

Provide separate power supplies to each item of equipment, as required, comprising a primary mains 230 V ac supply, and a secondary/back-up dc power supply unit, incorporating a battery charger, for the specified system operating voltage. Ensure that power supplies comply with BS 5839-1.

Provide power supplies for the following items:

- ~ main control and indication panel, including ancillary control and indication equipment
- ~ repeat indicator panels
- ~ interface units
- ~ other ancillary items requiring power
- ~ all interfaced equipment drawing power from fire detection and alarm system

Provide fault monitoring and alarm indication for:

- ~ mains power failure
- ~ battery power failure
- ~ charger output failure

712 Mains power supplies

Provide a dedicated, lockable fused switch / MCB, finished red in colour by the manufacturer and labelled in a durable fade-resistant material "Fire Alarm - Do not switch off". Install the lockable fused switch / MCB, in the essential side of the main LV distribution panel where an essential supply is provided, or the main LV distribution panel where there is no essential supply. Terminate this supply in the main annunciator/control panel power supply section.

Connect the power supplies to a dedicated distribution board for fire alarm equipment. Connect each supply to equipment via a double-pole isolation device key switch, suitably labelled. Do not use an RCD for protection unless required to comply with BS 7671.

Make the final connections to the equipment in heat-resistant LSF cable of a suitable rating enclosed within steel conduit. Label fuse connection units with details of the equipment served and include the wording "Fire Alarm - Do not switch off".

Ensure each supply is dedicated to a particular equipment item (and does NOT feed any non-fire alarm device).

Label appropriate MCBs in distribution boards to emphasise that supplies are serving fire alarm equipment. Do not supply power to fire detection and alarm system via an RCD unless necessary to comply with BS 7671.

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MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

713 Standby power supplies - battery and charger units

Ensure that the secondary power supply comprises a fully-encapsulated low-maintenance type NiCad or sealed lead-acid battery to BS 6290.

Ensure that the battery is able to sustain full system operation for 72 hours for Category P systems and 24 hours for Category L and M systems in quiescent mode, and thereafter operate sounders in all zones for 30 minutes continuously in the event of mains failure. Ensure that the battery can be fully charged from a fully discharged state within 24 hours.

Where power supply units are required for sounder circuits, ensure that they are suitably sized to cater for any reasonable future requirements. Ensure that the units are in full compliance with the requirements of BS 5839 and BS EN 54.

Ensure battery chargers are high quality constant potential type, with temperature compensation. Check and record charging voltages and currents during commissioning.

Do not take delivery of any batteries until the complete system is ready for test to ensure that the batteries do not degrade during the construction stage of the works.

Provide all fire alarm system control panels with 15% additional battery capacity and associated charging equipment spare capacity when sized for total system operation.

800 FIXING TO BUILDING 'FABRIC'

Comply with section Y90 of this specification.

900 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with section Y82 of this specification.

1000 TESTING AND COMMISSIONING

Comply with section Y81 of this specification.

Undertake all testing and commissioning of the system in accordance with standard and regulatory criteria, and specialised manufacturers' standard procedures, and to the satisfaction of the Contract Administrator, employer's representative and local fire authority, as required. Undertake all testing and commissioning to an integrated programme with other systems to ensure that all necessary power supplies are available, and that the correct operation of all interfaces with ancillary systems can be proved. Ensure that the commissioned system fully reflects the cause and effect schedule.

Undertake post-commissioning a one-week period soak test for all FDAS comprising 50 or more automatic detectors. Demonstrate the successful completion of this soak test, with no false alarms, to the Contract Administrator.

Undertake a FULL cause and effect test of all the devices on site, including the existing installation where applicable.

Ensure that installation and testing are undertaken in a planned and sequenced manner, in agreement with the occupier, to ensure minimal disruption to fire detection coverage to the premises.

Following the commissioning, allow for a two-day random demonstration including a run through of the cause and effect.

Undertake general electrical testing and commissioning in accordance with BS 7671, and the manufacturer's requirements.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

Provide, at a mutually agreeable time, separate training demonstrations of the full fire detection and alarm system to site engineers and the site occupier.

Perform all tests and rectify all non-conformities prior to commissioning and handover. Include the following:

- ~ tests as described in the current British Standards
- ~ sounder audibility tests throughout the building
- ~ functionality tests on a sample number of detector heads and break-glass units
- ~ all fire alarm interface tests
- ~ disabled refuge alarm / emergency voice communication system tests

Include the following aspiration smoke detection system tests:

- ~ overheated wire test, with 2 m of wire
- ~ open flame test with paper material
- ~ false alarm immune test with cement dust
- ~ functionality tests
- ~ all fire alarm interface tests

Record all results, along with all settings, and insert into the operating and maintenance manuals.

Provide all necessary commissioning.

1100 SCHEDULE OF INSTALLER'S SUBMISSIONS

Prepare all installation and record drawings, supply proper operating and maintenance instructions, and provide adequate demonstration to and training of the Client's representatives, for the system in accordance with the standards listed in the relevant A and B sections of this specification.

Issue a signed copy of the BS 5839: Installation Certificate / LPS 1014 certificate / SP203-1 certificate immediately on completion of the installation.

Issue a commissioning certificate within seven days of completion of commissioning, and ensure that the certificate clearly indicates any requirement for a period of soak testing.

Provide operating and maintenance instructions for all items of equipment including:

- ~ control panels
- ~ monitoring devices
- ~ autodiallers and modems
- ~ detection devices
- ~ manual alarm devices
- ~ alarm devices
- ~ amplifiers
- ~ backup systems
- ~ fault monitoring systems
- ~ loudspeakers

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W50 FIRE DETECTION AND ALARM

- ~ microphones
- ~ disc/tape players
- ~ recording equipment
- ~ digital message store
- ~ system software
- ~ system testing

Issue the following:

- ~ details of panel construction
- ~ battery sizing calculations
- ~ details of proposed field device locations
- ~ cause and effect diagram or schedule
- ~ zone diagram

Handover the following

- ~ The supply of spare or replacement keys for kiosks, which must be strictly controlled in order to prevent access by unauthorised persons.

END OF SECTION W50

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

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W51 EARTHING AND BONDING SYSTEMS

100 PERFORMANCE OBJECTIVES

To provide an earthing system for the transfer of electrical current to earth so that in the event of an earth fault, all earth fault currents are safely conducted to earth without danger to personnel or damage to equipment.

To provide an earthing system of sufficiently low impedance to facilitate operation of the electrical system protective devices such that all earth faults are cleared within the timescales specified in BS 7671.

To provide main and supplementary bonding in accordance with BS 7671, to create an equipotential zone of protection within all areas supplied by the associated electrical system, to ensure that all exposed conductive parts are at the same electrical potential as earth, and that personnel are not exposed to unsafe potentials under steady state or fault conditions.

To provide a reference point for the LV electrical system by providing a connection from the star-point of each transformer to earth.

To ensure that the consumer earthing requirements of the distribution network operator (DNO) supplying the building(s)/site are fully complied with.

200 DESIGN PARAMETERS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

The Electrical Supply Authority Requirements

The Electricity Safety, Quality and Continuity Regulations

The Electricity Supply Regulations

The Electricity at Work Regulations

BS 951	Electrical earthing. Clamps for earthing and bonding. Specification
BS 4444	Guide to electrical earth monitoring and protective conductor proving
BS 6387	Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions
BS 6701	Telecommunications equipment and telecommunications cabling. Specification for installation, operation and maintenance. Specification for installation, operation and maintenance
BS 7346-4	Components for smoke and heat control systems. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires. Code of practice
BS 7346-5	Components for smoke and heat control systems. Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing time-dependent design fires. Code of practice
BS 7346-7	Components for smoke and heat control systems. Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks

PROJECT RED ELECTRICAL INFRASTRUCTURE

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BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS EN 13599	Copper and copper alloys. Copper plate, sheet and strip for electrical purposes
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
BS EN 13636	Cathodic protection of buried metallic tanks and related piping
BS EN 15112	External cathodic protection of well casing
BS EN 50174-2	Information technology. Cabling installation. Installation planning and practices inside buildings
BS EN 50310	Telecommunications bonding networks for buildings and other structures
BS EN 50522	Earthing of power installations exceeding 1 kV a.c.
BS EN 61557-4	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Resistance of earth connection and equipotential bonding
BS EN 62305-1	Protection against lightning. General principles
BS EN 62305-2	Protection against lightning. Risk management
BS EN 62305-3	Protection against lightning. Physical damage to structures and life hazard
BS EN 62305-4	Protection against lightning. Electrical and electronic systems within structures
BS EN IEC 62561-2	Lightning protection system components (LPSC). Requirements for conductors and earth electrodes
BS IEC 60479-1	Effects of current on human beings and livestock. General aspects
BS IEC 60479-2	Effects of current on human beings and livestock. Special aspects ENA ER G12/3 Requirements for the application of protective multiple earthing to low voltage networks
ENA ER G98/1	Recommendations for the connection of small-scale embedded generators [up to 16A per phase] in parallel with public LV distribution networks
ENA ER G99	Recommendations for the connection of embedded generating plant to the Public Electricity Supplier's distribution systems
ENA ER P23/1	Guidance on Earth Fault Loop Impedance at Customers' Intake Supply Terminals
ENA ETR113	Notes of guidance for the protection of embedded generating plant up to 5MW for operation in parallel with Public Electricity Supplier's Distribution Systems (Northern Ireland only)
ENA TS 41-24	Guidelines for the Design, Installation, Testing and Maintenance of Main Earthing Systems in Substations
ENA TS 43-94	Earth rods and their connectors
IET Guidance Note 8	Earthing and bonding
IET Standards	Code of practice for grid connected photovoltaic systems
DoH HTM 06-01	Electrical services supply and distribution

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

210 System designation

Supply at High Voltage (HV)

Provide the building low voltage (LV) earthing system using a direct and permanent connection of the neutral point of the transformer to one or more electrodes driven into or buried in the ground.

Provide LV earthing in accordance with BS 7671.

Liaise with the DNO to ascertain whether connection is required/may be made between HV and LV earthing system. Refer to clause 610 below.

Supply at Low Voltage (LV)

TN-S system – with separate neutral and protective conductors throughout the system. (Note that HTM 06-01 requires that all primary and secondary distribution systems should be configured as TN-S.)

300 SYSTEM DESCRIPTION

The point of origin of the earthing for the installation is at the main earth bar within each of LV Switchroom A, LV Switchroom B and Chiller Switchroom from which the supplies are derived. The armouring and any CPC's associated with the submain cables are to ultimately terminate at this earth bar.

Refer to earthing schematic; RED-HLE-02-XX-DR-E-690-001

400 CONTROL REQUIREMENTS

Provide operation indication for surge suppression devices.

The earthing system is passive without further control requirements.

500 SCOPE OF WORKS

510 General

520 Responsibilities

Responsibilities of the electrical installer include:

- ~ Liaise with the distribution network operator (DNO) regarding the earthing arrangements of the installation and confirm these arrangements in writing to the Contract Administrator.
- ~ Ensure that any part of the earth fault current path provided by the DNO or others is suitable for the operation of the earth fault protection provided by the installer.
- ~ Liaise with the main contractor regarding the phasing of the works
- ~ Take responsibility for the electrical continuity of all trunking, tray, basket, cable containment, gas pipes, water pipes, ductwork etc. and for testing and demonstrating such continuity prior to connection to the earthing system.
- ~ Take responsibility for liaison with all installers, and for the provision, installation and connection of all main earth connections to metallic services containment.
- ~ Take responsibility, for electrical continuity of pipework (including pumps etc.) and ductwork (including AHUs, FCUs, etc) and provision of earth connection points on each for the connection of earth bonds

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

- ~ Take responsibility for bonding of structural steel work, lightning protection system, extraneous metalwork, including hand railings, ladders, raised metal floors etc.
- ~ Provision and testing of earthing to desks.

530 Detail co-ordination

Carry out a careful co-ordination exercise of the mechanical systems installed under the engineering works package, together with metalwork provided under other works packages such as ceilings, architectural metalwork, and floors, to ensure that a consistent earthing installation is achieved.

Liaise with all other relevant installers and systems specialists, to provide a comprehensive and consistent earthing installation throughout the building(s).

Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc. with the Contract Administrator.

Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

540 Initial soil tests

Carry out soil tests in accordance with BS 7430 and BS 1377 to establish soil electrical resistivity prior to commencement of the works.

Report the results to the Contract Administrator.

600 EARTHING REQUIREMENTS

Comply with section Y80 of this specification.

610 Sub-station earthing

Demonstrate by design calculation and ensure that the value of touch potential imposed upon the LV systems during a HV fault does not exceed the safety limits given in Annex NA of BS EN 50522. Undertake the calculation using the recommendations and guidance given in ENA ER S 34 on assessing the rise of earth potential. Confirm and demonstrate design calculation using direct measurement of earth electrode resistance / current injection test once the system is installed.

Connect the LV cable armour to the LV switchboard common earth bar, and the neutral conductor to the LV switchboard neutral/earth busbar. Link the LV switchboard earth bars via a bolted connection. Provide LV earthing systems to BS 7671 and BS 7430 for a TN-S LV system.

Ensure that all earthing systems meet any specific DNO requirement.

Directly connect the HV earth system/exposed conductive parts in the substation to the earth electrode system via the earth terminal on the LV switchgear and/or HV/LV transformer. Use an adequately sized copper tape (at least 25mm x 4mm), or copper insulated cable (at least 95mm²) with PVC/ insulation.

Ensure that the earth resistance of the combined earths (HV exposed conductive parts plus LV neutral earth plus connections with earth associated with the cables connected to the substations via their sheaths) complies with the requirements to avoid danger from step potentials, touch potentials and any transfer potential risk during fault conditions.

Bond the metallic sheath and/or armouring of the HV cable to the LV earth system.

Ensure that all exposed conductive parts in the part of the substation containing HV equipment are isolated from the LV earth electrode system, the earth terminal on the LV switchgear and the neutral point of the transformer's secondary windings.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

Provide separate earth electrode systems for the earthing of the HV equipment and the LV equipment.

Ensure that the resistance of the HV earth electrode system at the substation (measured independently) does not exceed the maximum resistance to earth specified by the associated utility and in any case not more than 20Ω . Ensure the layout of the buried earth conductors that form the electrode provide adequate control of step and touch potentials to protect operators. Ensure proper consideration of the earthing of the substation fence to ensure there is no risk of dangerous touch or step voltages for any person inside or outside the substation.

Ensure that the HV and LV earth electrode systems have a separation distance derived through calculation and/or measurement sufficient to ensure touch voltage limits are complied with for the LV installation and in any instance to ensure no earthed (or possibly earthed) metal parts are closer than 3 metres apart.

Ensure that the metallic sheath and/or armouring of the HV cable is bonded to the transformer or HV switchgear casing by an insulated gland fitted to the secondary terminal box.

Do not provide any metallic sheath and/or armouring of the LV cable and earth the transformer star point at the LV switchboard.

Ensure that the resistance of the LV neutral earth electrode system at the substation (measured independently) does not exceed the maximum resistance to earth specified by the associated utility and in any case not more than 20Ω .

611 LV neutral earth

Bond the neutral point of the transformer secondary winding to the neutral/earth busbar in the LV distribution switch panel through a bolted link.

Ensure that the neutral/earth busbar is connected to the common earth bar within the LV distribution switch panel, through a bolted link.

Connect the separate sub-station earth bar (at least 75mm x 6mm copper) to facilitate the connection of metalwork in the substation, the earth electrodes, the building equipotential bonding and the main switchgear LV earth bar.

Ensure that the resistance of the LV neutral earth electrode system at the substation (measured independently) does not exceed 1Ω .

620 Earth electrode system

Provide a substation and HV installation earth electrode system as indicated on the drawings.

Provide earth rods driven into the ground in an area previously agreed for the installation of earth electrodes. Drive the rods vertically into the ground until their tops are a minimum of 600mm below the surface. Ensure that each driven rod is spatially separated from the next by 3m or the length of the longest rod, whichever is greater.

Obtain any mechanical tool or device needed to drive the rods into the earth at the required depth.

Prior to driving any electrodes into the ground, check the selected area with an electronic scanning device, for any buried services.

Divide the earth rod system into two equal parts so that testing can be carried out on each half without loss of earthing facilities.

Connect each part of the system to proprietary testing links using insulated conductors, terminating at the substation earth bar

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W51 EARTHING AND BONDING SYSTEMS

Construct the LV earth electrode system using 12mm thick ribbed cast iron electrode plates, buried at a level not less than 500mm below the ground surface. Where more than one plate-electrode is required, space them at a distance of no less than 2m.

Provide and locate the earth electrode system as indicated on the drawings

Encase the electrode in an electrically conductive aggregate material such as [specify where required] in a comprehensive lattice arrangement. Protect all earth connections from corrosion by a suitable compound impregnated waterproof tape.

Where the ground has high soil resistivity such that the final resistance value of the earth electrode(s) cannot be guaranteed, provide additional electrodes, inspection covers and inter-connecting tape to achieve the stipulated resistance over and above that shown on the drawings or described herein.

Determine by test the exact number of electrodes needed within each grid to achieve the stipulated resistance to the mass of earth. If any additional equipment is required, obtain approval from the engineer prior to installation.

Connect earth electrodes in arrays using bronze purpose-made clamps with compatible material high tensile bolts and 25mm x 6mm plain copper tape between electrodes. Make connections at the tops of electrodes; ensure that horizontal tape runs between electrodes are 750mm below finished ground level; and provide the necessary vertical tape lengths.

Provide each electrode head with a purpose-made concrete inspection housing having a removable concrete 'plug'. Arrange the housings to be accessible and visible at finished ground level to enable tests to be periodically undertaken. Provide seals to prevent the ingress of ground water.

Ensure that connections to the earth electrodes are readily accessible for periodic inspection and protected against mechanical damage and corrosion. Make the connection to the rod by means of a purpose-made clamp and lay below ground level in a concrete inspection pit having a removable cover prominently inscribed "Earth".

For earth connection cables buried below ground use PVC sheathed type. Ensure that the cables are a minimum 0.6m below the ground and sized in accordance with BS 7671.

Base the tender price on the design shown on the tender drawings and in this specification. Provide rates for all earthing system components (specialist soil aggregate, earth spikes, conductors etc.) within the tender submission so that the price can be adjusted to suit the final design, if necessary, should this need to vary based on the soil resistivity survey results.

630 LV system earthing

Install an earthing system to meet the requirements of BS 7671. Base the system on separate neutral and protective conductors throughout the installation.

Install earth bars in the locations indicated on the drawings, final positions to be agreed on site. Using adequately sized copper tape (at least 75mm x 6mm) or copper cable (at least 95mm²), both with LSZH insulation, connect the main earth bar to the following:

- ~ neutral of the source of energy [main earth electrode system]
- ~ main LV distribution panel(s)
- ~ lightning protection system/structural steelwork
- ~ cable tray/ladder system
- ~ secondary earth bar(s).

Connect the following local items to the secondary earth bars, using LSZH insulated hard drawn copper cables:

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MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

- ~ all electrical distribution equipment
- ~ all building structural steelwork
- ~ all mechanical plant including ductwork and pipework.

Provide circuit protective conductors (CPCs) as follows:

- ~ SWA of the XLPE/SWA/LSZH sub-main distribution cabling with additional CPCs where indicated on the drawings/cable schedule
- ~ dedicated earth conductor of fire-rated cables complying with BS 6387 CWZ
- ~ separate CPC for all final circuits comprising LSZH sheathed / insulated cables installed in conduit and trunking distribution systems.

Ensure separate CPCs for final circuits are of the same cross-sectional area as that of the phase conductor. All as indicated on the drawings.

631 Wiring systems in relation to external influences

Ensure that all wiring systems follow the BS 7671 guidance on protection when routed through building voids.

Install cables in earthed containment such as steel conduit, trunking or ducting when necessary.

Ensure that earthing continuity is maintained throughout in compliance with BS 7671.

632 LV Generator earthing

Provide a direct connection of the neutral point to a single generator (the star connection of a three-phase winding) to the LV earth electrode system. Install the LV earth electrode system in accordance with BS 7671 and clause 620 above.

Provide the neutral earthing arrangement to meet the requirements of the particular system as indicated on the drawings, comprising a solid neutral connection to the earth electrode / a switched neutral connection to the earth electrode / a neutral earth connection provided by parallel-connected alternator or supply / a static balancer installed to provide a neutral star point. ¶

Ensure that the neutral earth connection comprises an earth lead between the earth electrode system and the star point on the generator.

Ensure that the exposed conductive parts of plant, equipment and appliances connected to a neutral earthed system are separately connected to the earthing system.

633 External socket outlets and equipment

Note that the term "external socket outlet and equipment" applies to any socket outlet or equipment that itself is located outside the equipotential bonding zone of the main electrical installation or provided for the specific purpose of enabling mobile or portable equipment to be used outside this zone.

Protect all external socket outlets with a residual current device (RCD) having an operating current not greater than 30mA.

634 Information technology circuits

Ensure that the installation is undertaken in accordance with BS EN 50310 and BS EN 50174.

Ensure that the potential rise in Information Technology circuits due to power system earth faults is limited in accordance with BS 6701.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

640 Equipment earthing

641 Circuit protective conductors

Provide circuit protective conductors as:

separate copper circuit protective conductors with yellow/green insulation

armouring and/or metal sheaths of armoured cable

armouring and/or metal sheaths of armoured cable with auxiliary separate copper circuit protective conductors with yellow/green insulation

an integral protective conductor of any multi-core cable

Ensure that the size of the protective conductor is in accordance with BS 7671 and is as indicated on the drawings. Verify that no protective conductor is smaller than the minimum size of 1.5mm².

Terminate bolted connections with compression type lugs formed by an automatic purpose-made machine.

Bond the metal sheaths and/or armouring of paper and PVC insulated cables to the metal parts of the equipment to which they are connected, utilising a proprietary brass earthing tag and brass nut and bolt.

When flexible conduit is used, ensure that the protective conductor at the equipment end is made off to the equipment earth terminal. Install the protective conductor within the conduit and size suitably for the circuit(s) passing through.

700 BONDING REQUIREMENTS

710 Bonding extraneous conductive parts

Bond extraneous conductive parts to earth in accordance with BS 7671 and BS 7430.

Ensure all building incoming main metallic services and building structure are securely connected to the main earth bar. Ensure that the following services are bonded:

- ~ main water pipes
- ~ main gas pipes
- ~ fuel oil pipes
- ~ exposed metallic parts of building structure
- ~ thermal insulation metallic cladding
- ~ metallic cable sheaths of all cables
- ~ lightning protection systems.

Bond all simultaneously accessible conductive parts to the protective conductor system using supplementary equipotential bonds.

Agree on site with the Contract Administrator the final positions for equipotential bonding of piped services prior to commencement of the installation.

For the purposes of this clause a building is defined as a separate structure. Structures linked by a corridor, subway or bridge are considered to be separate structures.

Bond together metallic water pipes, main metallic gas pipes, other metallic service pipes and metallic ventilation ducting, oil pipe services, piped gas systems, etc., entering/leaving plant rooms, boiler

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MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

houses, calorifier rooms, bathrooms, kitchens and other wet-process areas, and bond to the electrical installation protective conductor system.

Ensure that all exposed or extraneous conductive parts having a resistance to earth of less than $1M\Omega$ are bonded to the electrical services earth.

Prove each circuit protective conductor prior to making any supplementary bonding connection.

Bond final connections of all extraneous metalwork by means of a bolted type lug connection in a suitable position to be agreed with the engineer. Use only bronze nuts and washers when fixing earth tape.

No main or supplementary bonding cables to be less than $6mm^2$ /copper LSZH-covered, green/yellow.

Connect all the protective conductors for bonding to the earthing system at the nearest convenient earthing terminal provided in an outlet box or equal. Install conductors within ducts etc., and where necessary within conduits to outlet boxes.

720 Bonding exposed conductive parts

Carry out the equipotential bonding of the extraneous metalwork in the building in accordance with BS 7671.

Ensure the exposed metallic parts of the building structure are securely connected to the LV earth system.

Provide all conduit and trunking distribution services with equipotential and supplementary bonding systems throughout the installation, to ensure in conjunction with the separate CPC requirements that maximum earth continuity is provided for all such services.

Provide primary cable ladder and tray distribution systems with earth straps at each joint position and connect at source to the main earthing reference.

Bond each distribution board and switch panel, in addition to the CPC reference provided by the supply cable armouring, by a separate LSZH cable to the cable containment system.

730 Equipotential bonding of structural steelwork

Install the equipotential bonding of the structural steelwork in the building in accordance with BS 7671.

Allow for the equipotential bonding of the structural steelwork in X No. positions, the exact positions to be agreed with the Contract Administrator.

Bond final connections of the structural steelwork by means of a bolted type lug connection in a suitable position to be agreed with the Contract Administrator.

Connect the protective conductors for bonding to the respective sub-main distribution board earth terminal.

740 Other bonding requirements

Ensure any exposed or extraneous metalwork, other than any live part, forming part of the electrical installation is at earth potential.

Ensure that metallic structures forming part of sub-stations eg fencing, are bonded to earth.

Ensure all LV socket outlets have a green/yellow LSZH insulated $2.5mm^2$ stranded copper conductor as a 'fly lead', connected between earth terminals secured to both socket assembly and socket box.

Provide each lighting switch grid with an earth terminal and a green/ yellow LSZH insulated $1.5mm^2$ stranded copper conductor as a 'fly lead', connected between earth terminal and grid assembly.

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W51 EARTHING AND BONDING SYSTEMS

Provide green/yellow LSZH insulated fly leads (6.0mm² minimum) for all hinged panels of switches, switchgear, control cubicles, distribution boards, etc., Route/protect the 'fly leads' to obviate damage to the cables when panels are opened and closed.

Provide protective conductors for the full length of all busbar trunking systems. Ensure sizes are in accordance with BS 7671. Fix tinned copper tape externally to the side of the busbar trunking system using brass bolts and double (locking) nuts. Ensure that the maximum fixing centres are 900mm and each section of rising busbar trunking is securely bonded to the tape.

Provide and test earthing to desks in accordance with the requirements of BS 6396.

800 INSTALLATION

810 General

Carry out the installation in accordance with BS 7671 and BS 7430.

Make joints in earthing conductors by any of the following methods:

- ~ tin the jointed area of conductor, install minimum of four rivets, then sweat joint solid. Wrap joint in a durable, conformable, cold-applied, petrolatum-impregnated synthetic fibre tape offering corrosion protection (e.g. Denso tape) below ground.
- ~ proprietary crimps, formed by purpose-made automatic machine, ensuring that a crimp, once started cannot be released until full pressure and crimp depth have been achieved. Wrap joint in a durable, conformable, cold-applied, petrolatum-impregnated synthetic fibre tape offering corrosion protection (e.g. to Denso tape) below ground.
- ~ proprietary fusion welding system. Installed strictly in accordance with manufacturer's instructions. Wrap joints in a durable, conformable, cold-applied, petrolatum-impregnated synthetic fibre tape offering corrosion protection (e.g. to Denso tape) below ground.

Ensure that where holes are drilled in the copper tape for connection to items of plant the effective cross-sectional area of the connection is not less than that required to comply with BS 7671. Tin the connected surface area.

Use clamps to BS 951 for bonding of pipes.

Provide all earthing cables with suitable mechanical protection, labelled and clearly identified throughout the installation on the cable tray, ladder, trunking and conduit distribution facilities.

Undertake all earthing and bonding in an inconspicuous and approved manner wherever possible. Agree all cabling routes with the Contract Administrator prior to commencement of the installation.

Where the building's structural metalwork forms part of the earthing system, whose entirety is made up of multiple metallic building elements, ensure the electrical joint between them, and to the bonding conductor system, is formed by welding, or a clamped connector, or a pressure connector

900 INSTALLER'S SUBMISSIONS

Submit the following for the Contract Administrator's comment:

Submit operating and maintenance instructions for all items of equipment including:

910 Handover documentation

Fully record all tests and submit all test results in writing to the engineer. Include the results in the operating and maintenance manuals.

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MANCHESTER ROYAL INFIRMARY

W51 EARTHING AND BONDING SYSTEMS

Complete the respective distribution board schedules with measured test values for each site location, and provide copies at the respective item of switchgear and within the O&M.

Provide specific information as follows:

- ~ fault levels at all main, sub-main and distribution boards
- ~ final earth loop impedance values at equipment locations for all circuits
- ~ test information and records at installation completion. These are required for future use by the Client's electrical maintenance engineers in meeting their obligations on maintenance and periodic testing as required by BS 7671.

END OF SECTION W51

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHESTER ROYAL INFIRMARY

W52 LIGHTNING PROTECTION SYSTEMS AND SURGE PROTECTION DEVICES

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800	FIXING TO BUILDING FABRIC
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W52 LIGHTNING PROTECTION SYSTEMS AND SURGE PROTECTION DEVICES

100 PERFORMANCE OBJECTIVES

To perform a comprehensive risk assessment to BS EN 62305-2 to identify and quantify all risks in order to determine the appropriate level of lightning protection required to meet this specification.

To design, install, commission and test a complete Lightning Protection System (LPS) to BS EN 62305-3 to provide lightning protection for the proposed Building / structure that will:

- ~ intercept a lightning flash to the structure (using an air termination system)
- ~ conduct the lightning current safely towards earth (using a down conductor system)
- ~ disperse the lightning current into the earth (using an earth-termination system)

To design, install and commission all System Protection Measures (SPM) to BS EN 62305-4 to protect against failure of internal systems due to Lightning Electromagnetic Impulse (LEMP).

To ensure that the design, installation and commissioning of the LPS and SPM is undertaken by a specialist lightning protection company that is a member of the Association of Technical Lightning & Access Specialists (ATLAS) and is BS EN ISO 9001 certified for quality assurance to provide all required technical advice, installation and monitoring services to ensure a complete installation as outlined in this specification.

To ensure that the LPS interconnects with the existing building LPS.

To ensure that fixed metallic components of the building(s) including steel chimneys, flue liners, TV antennae, rainwater disposal systems, roof mounted equipment, etc are protected as a part of the LPS.

To use in the system(s) materials that are resistant to corrosion from the environmental conditions to which the system is exposed, and thus minimize the risk of degradation of the function of the LPS and staining of the external fabric of the building(s).

To ensure that the system(s) does not/do not undermine the integrity, weatherproofing and waterproofing systems of roofs, nor any other part of a building's fabric.

To arrange, subject to agreement with adjacent building's owner, that the system is interconnected with that on the existing adjacent building.

To enable the system to be readily extended to interconnect with the proposed future extension of the building.

To enable the system to be readily extended in future to interconnect with the proposed adjoining building.

200 DESIGN PARAMETERS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

Dangerous Substances and Explosive Atmospheres Regulations

BS 951 Electrical earthing. Clamps for earthing and bonding. Specification

BS 7430 Code of practice for protective earthing of electrical installations

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BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS EN 1127-1	Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology
BS EN 61557-4	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Resistance of earth connection and equipotential bonding
BS EN 61643-11	Low-voltage surge protective devices. Surge protective devices connected to low-voltage power systems. Requirements and test methods
BS EN 61643-21	Low voltage surge protective devices. Surge protective devices connected to telecommunications and signalling networks. Performance requirements and testing methods
BS EN 62305-1	Protection against lightning. General principles
BS EN 62305-2	Protection against lightning. Risk management
BS EN 62305-3	Protection against lightning. Physical damage to structures and life hazard
BS EN 62305-4	Protection against lightning. Electrical and electronic systems within structures
BS EN 62561-1	Lightning Protection System Components (LPSC). Requirements for connection components
BS EN 62561-2	Lightning Protection System Components (LPSC). Requirements for conductors and earth electrodes
BS EN 62561-3	Lightning Protection System Components (LPSC). Requirements for isolating spark gaps
BS EN 62561-4	Lightning Protection System Components (LPSC). Requirements for conductor fasteners
BS EN 62561-5	Lightning Protection System Components (LPSC). Requirements for earth electrode inspection housings and earth electrode seals
BS EN 62561-6	Lightning Protection System Components (LPSC). Requirements for lightning strike counters (LSC)
BS EN 62561-7	Lightning Protection System Components (LPSC). Requirements for earthing enhancing compounds

210 Lightning protection level (LPL)

Undertake risk assessment against the following tolerable risk (R_T) levels:

- ~ In accordance with BS EN 62305-2 Annex NF

Ensure that the LPS achieves the highest Lightning Protection Level (LPL) from the following:

- ~ Lightning protection level as determined by risk assessment

220 System protection measures (SPM)

Provide all internal zones (LPZ 1 or higher) with SPM to protect against LEMP and to reduce the risk of equipment and system failure resulting from a lightning strike. Ensure that the totality of SPM provides protection from damage to internal equipment arising from:

- ~ Surges due to lightning strikes to the structure
- ~ Surges due to lightning strikes near the structure

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- ~ Surges due to lightning strike on or near lines connected to the structure
- ~ Lightning strike magnetic field directly coupling with equipment

Provide all SPM in accordance with BS EN 62305-4.

300 SYSTEM DESCRIPTION

Provide a lightning protection system as required to provide coverage to the building.

400 CONTROL REQUIREMENTS

Passive system with no control requirements.

500 SCOPE OF WORKS

510 Responsibilities

The scope of work for the lightning protection system and system protection measures is as shown on the drawings, schedules, this specification, and other documentation used to describe the LPS and SPM. Perform and deliver the scope of works to conform to the relevant A Sections of the project specification.

Agree before returning a tender, the assignment of responsibility for supply and installation of surge protection devices between the electrical installer and the LPS installer. Ensure all requirements of the specification and drawings are included in full between the bids to form a complete combined tender package.

Unless otherwise agreed, the provision and installation of all required SPDs is the responsibility of the electrical installer.

520 Detail Coordination

Agree all proposed methods of fixing the system(s) to structure, roof, cladding, chimneys, equipment, etc with the Contract Administrator.

Agree the colours and finishes of all exposed materials of the system(s) with the Contract Administrator.

600 SYSTEM COMPONENTS

610 General

Ensure all lightning protection system components (LPSC) are compliant with the relevant part(s) of BS EN 62561.

Ensure that all components of the system are selected and installed fully in accordance with the manufacturer's written installation instructions.

Provide all system components with regard to the required LPL.

Ensure electrical insulation between air terminations, down conductors, and structural and internal system metal work is provided by separation distance in accordance with BS EN 62305-3.

620 Air termination systems

Provide an air termination system based on a determination by the rolling sphere/projection angle/mesh method of BS 62305-3. Use finials (air-rods), catenary wires, masts or natural

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components for air terminations. Locate air terminations at corners, exposed points and edges of the building(s) as determined by the method used.

Where the air termination system comprises finials, ensure that these are placed outside of the minimum separation distance between the finial and un-bonded equipment to prevent flash over.

Ensure the air termination system is designed and installed in strict compliance with BS EN 62305-3.

Provide only passive measures in the interception and conveyance of direct lightning strikes.

Coordinate with all appropriate parties (including the main contractor, roofing contractor, cladding contractor etc), to ensure that the LPS is installed at an appropriate time during the construction process.

Provide all necessary features (eg purpose manufactured connectors, surface treatment of materials, etc), to prevent electrolytic corrosion between dissimilar metals.

Configure the air termination network to have the minimum number of joints.

Bond the air termination grid to every down conductor.

621 Structures with a flat roof

Provide lightning protection to parapets using an exposed perimeter copper/aluminium 25mm x 3mm flat conductor tape, bonded to the grid and secured using manufacturer's proprietary fixings suited to the parapet surface material.

Provide 25mm x 3mm proprietary roof joints and fixings as required to secure the air termination network.

Provide LPS connection to mechanical equipment. Bond mechanical equipment to nearby vertical air rod termination or air termination system, as appropriate.

Provide LPS connection to metallic structure. Include connections to roof top balustrading, lift shaft structure, roof steelwork, roof metallic covering and coping, as appropriate.

Provide LPS connections to all metallic structure items and mechanical equipment with conductor tape.

Where LPS conductor tape is required to be in contact with planted mediums, such as in green roof systems, install PVC coated copper tape bonded to the rest of the LPS. Where the LPS tape is not readily accessible for inspection, provide accessible test links at the points of connection with the rest of the LPS so that the inaccessible section may be separately tested for integrity.

630 Down conductor network

Provide a down conductor network based on PVC covered conductor tapes (note requirement for architectural co-ordination regarding the colour and routing of PVC covered down conductors).

Provide down conductors at each corner, where possible, with all other down conductors at intervals specified in BS 62305 for the given LPL.

Only use natural components of the building structure as part of the down conductor system in accordance with BS EN 62305-3.

Do not allow down conductors to be installed through ATEX zones unless they have been manufactured to be fully encased in suitable insulation to prevent flashover.

Ensure that all down conductors take the most direct route, without bends and without 're-entrant loops', from the air termination network to the earth termination network.

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Ensure that all cantilevered elements of the structure are treated in accordance with the relevant clauses of BS EN 62305-3.

Configure the down conductors to have the minimum number of joints.

Where driven rods are provided as an earth termination method, provide a test joint at each down conductor connection to the earth electrode system. Arrange that the test joint is closed in normal operation and can only be opened with the aid of a tool.

Arrange that there are no joints between the test joint and the connection to the electrode in any down conductor.

Protect the down conductors from ground level corrosion by a PVC sleeve for a distance of 0.3m above and below ground.

Test and confirm the continuity of each down conductor from the air termination to earth termination positions. Where required, connect by a bonding conductor any part of the down conductor found to be electrically isolated from the remainder of the conductor.

631 Connectors, clamps, links, bonds and bolts

Ensure that all connectors, clamps and links between tapes, all clamps of tapes onto structural reinforcing steel and structural steelwork, and all bonds of tapes onto components that are not part of the LPS, are effective in reliably maintaining electrical continuity with negligible electrical resistance, and comply with BS EN 62561.

Clean all surfaces of conductors and apply a moisture inhibiting paste before jointing, and fit a proprietary waterproof shroud, colour matched to the PVC coloured conductor.

Robustly secure and fix all connectors, clamps, links and bonds so that the system is not damaged in operation.

Provide welded joints for all joints in LPS conductors that are buried in the ground.

632 Protection from touch and step voltages

Ensure that all/specifically identified down conductors protect against hazardous touch voltages by providing:

- ~ insulation of exposed down conductor to give 100kV, 1.2/50µs impulse withstand voltage, eg at least 3mm of cross-linked polyethylene
- ~ physical restrictions and/or warning notices to minimise probability of down conductors being touched

Ensure that all/specifically identified down conductors protect against hazardous step voltages by providing:

- ~ equipotentialization by means of a meshed earth termination systems
- ~ physical restrictions and/or warning notices to minimise probability of access to the dangerous area, within 3m of down conductor

640 Earth termination network

Undertake an appropriate survey of the conditions of the site, including measurements of soil resistivity, and report to the Contract Administrator.

Design the earthing termination network on the basis of the soil survey results and BS 7430 calculations for determining the approximate resistance expected from vertical and/or horizontal earth electrodes.

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Test the installed earth termination network in accordance with BS EN 62305 to demonstrate earthing resistance is below 10 ohms. A test result exceeding 10 ohms is a test fail. Install further earth rods as necessary to achieve an earthing resistance less than 10 ohms on occasion of test failure.

Ensure that every earth electrode is of a material that provides good resistance to corrosion and is capable of carrying high currents repeatedly.

Ensure that every electrode has an anti-corrosion treatment, suitably robust to provide good levels of longevity, even in soils with high erosive effects.

Ensure that every point of connection to the earth termination network is removable and easily Ensure that the total number of earth electrodes is not less than two.

Obtain the agreement of the Contract Administrator to the proposed method of earth termination network at the time of submission of working drawings, and prior to commencement of the Works.

Provide a BS EN 62305-3 Type A earth termination system comprising:

- ~ 25mm x 3mm copper connections from each down conductor to earthing electrodes at ground level
- ~ bi-metallic joints as required
- ~ earthing electrodes comprising 2500mm x 16mm steel-cored copper bond electrodes complete with gunmetal fittings, earth inspection pits and covers, and 25mm x 3mm bare copper interconnecting tape

Distribute electrodes as uniformly as possible to minimize electrical coupling effects in the earth.

Install solid copper rods in soft earth where low resistance is required. Install copper clad steel rods in well compacted or stony ground where rods must be power driven.

Provide a BS EN 62305-3 Type B earth termination system comprising a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length.

Ensure the mean radius of the area enclosed by the ring complies with the requirements of BS EN 62305 with regard to the LPL.

Connect additional electrodes, comprising 2500mm x 16mm steel-cored copper bond electrodes complete with gunmetal fittings, earth inspection pits and covers, to the ring earth electrode at points where the down conductors are connected.

Bury ring earth electrodes at a minimum depth of 0.5m, at a distance of approximately 1m from external walls.

Provide a BS EN 62305-3 Type B earth termination system using a foundation earth electrode comprising conductors installed in the concrete of the foundations.

Ensure the mean radius of the area enclosed by the foundation earth electrode complies with the requirements of BS EN 62305 with regard to the LPL.

Design and install foundation earth electrode in accordance with BS 62305-3.

641 Foundation earth electrodes (utilisation of structural reinforcing bars)

Use the natural components of the building structure in lieu of, and/or to supplement the earth termination system described above, in accordance with the following clauses.

Liaise with the structural engineer and agree the design requirements to ensure full continuity between the earth reinforcing bars and the lightning protection connections above ground.

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Where the maximum 10 ohm earthing resistance cannot be achieved, supplement the natural earth electrode system with earth conductor and/or add earth electrode rods until the required value is achieved.

642 Test points

Connect every earth electrode to its corresponding down conductor with a visible and accessible test joint incorporated into its down conductor path.

Ensure that every test joint is a mechanically strong clamp made from corrosion resistant metal with low electrical resistance.

Install earth electrodes electrically separated from the LPS system, as reference electrodes for the purpose of periodic testing of the earthing system and LPS performance. Install a minimum of one test point for every 100m of building perimeter.

Provide an electrical connection from the earthed structure within the reference electrode enclosure to enable measurement between the foundation earth and that of the reference electrode.

Ensure that each deep-driven earth rod is a minimum of 2400mm in length.

Provide at each deep-driven earth electrode an earth electrode inspection pit incorporating a test chamber complete with test clamp for bonding.

Ensure that, where test chambers are installed, they take the form of ground recessed inspection pits. Where inspection pits are installed within hardscape areas ensure the chambers are concrete. Where inspection pits are installed in the soft, ensure they are made of a durable plastic.

650 Bonding of other systems and components

Bond the LPS to its associated main electricity earthing terminal.

Electrically bond all extraneous conductive parts connected to the structure of the building(s), including all metal projections on or above the main surface of the roof(s) to the LPS. This includes but is not limited to the following:

- ~ external mechanical plant and equipment
- ~ screens, louvres and grilles
- ~ copings
- ~ vents and cowls
- ~ metal roof coverings
- ~ exposed steelwork
- ~ water pipes
- ~ gas pipes
- ~ gutters
- ~ metallic cladding and curtain walling
- ~ generator housings
- ~ flues

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W52 LIGHTNING PROTECTION SYSTEMS AND SURGE PROTECTION DEVICES

700 EQUIPMENT

710 Internal lightning protection system

Provide internal lightning protection for the Building in accordance with BS EN 62305-3.

Review specification section W51 for details of the earthing and bonding arrangement for the Building – engineer to specify. Confirm to the Contract Administrator that the proposals for earthing and bonding arrangement contained within W51 meet the requirements of BS EN 62305 in respect of internal lightning protection.

Obtain the approval of the Contract Administrator for any additional earthing and bonding required to meet the requirements of BS EN 62305. Provide details of additional requirements at the time of submission of working drawings and prior to commencement of the Works.

720 Surge protection devices (SPD)

Install all SPDs in accordance with manufacturers' recommendations at appropriate locations suited to the application and equipment being protected.

Provide all SPDs to BS EN 61643 with the correct current surge rating, voltage protection levels and connection method suitable for the particular application and the structure's electrical system. Ensure all SPDs are installed to BS EN 62305-4 and operate with 'line to earth', 'line to neutral', 'neutral to earth', or 'line to line' mode of protection, according to the application.

Ensure that all SPDs are coordinated across LPZs. Provide all SPDs with visual indication that they are operational, and mount where readily accessible and visible.

Protect incoming and outgoing electrical service cables at the LPZ 0/1 boundary with a standard equipotential bonding Type 1 SPD to provide lightning current protection. Install Type 1 SPDs at the service entrance / main distribution board or other appropriate location to cover non-typical use.

Protect incoming and outgoing IT and communications service cables at the LPZ 0/1 boundary with a standard equipotential bonding Type 1 SPD (rated in accordance with BS EN 62305) to provide lightning current protection.

Protect all internal electrical and electronic systems at the LPZ 1/2 boundary with a coordinated set of standard Type 2 SPDs. Install Type 2 SPDs at the sub-distribution boards, or other appropriate location.

Protect all internal IT and communication systems at the LPZ 1/2 boundary with a coordinated set of standard Type 2 SPDs.

Protect the following designated equipment at the LPZ 2/3 boundary with a coordinated Type 3 SPD:

- ~ Equipment A
- ~ Equipment B

Confirm to the Contract Administrator that the proposals for LEMP protection contained in this specification meet the requirements of BS EN 62305.

Obtain the approval of the Contract Administrator for any additional protection required to meet the requirements of BS EN 62305; provide details of additional requirements at the time of submission of working drawings and prior to commencement of the Works.

Protect all ATEX zones with a coordinated set of SPDs on services entering or exiting the ATEX zone using ATEX approved SPDs. Install SPDs at the boundary to the ATEX zone, and within ATEX zone 1 and 2, using an isolated screen SPD.

Provide each surge protection device (SPD) with volt free contacts to signal the BMS for remote indication of SPD activation.

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800 FIXING TO BUILDING FABRIC

Comply with Section Y90 of this specification.

Use stainless steel screws to prevent galvanic action where white metal plug fixings are used.

900 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with Section Y82 of this specification.

Install a sign, complying with BS EN 62305, at the main electricity earth terminal in every building to which the LPS is bonded, warning that it should not be disconnected.

Install a sign at the door providing access to the roof, warning that the LPS must not be undermined by extending the building, eg by adding a flagpole to the roof. Write the same warning in the operating and maintenance instructions.

Ensure that every electrode inspection pit cover bears the wording 'Lightning protection system earth'.

Provide warning notices as required by clause 632.

1000 TESTING AND COMMISSIONING

1010 Tests

Ensure that the complete LPS is fully tested by the specialist installer in accordance with BS EN 62305.

Arrange a mutually agreed programme for the demonstration of the LPS with the Contract Administrator. Prepare a method statement for the test, commissioning and demonstration stating exactly how these are to be carried out, and submit the statement to the Contract Administrator for comment.

1020 Procedure

Complete, test and commission the structural lightning protection system at an early stage in order that the building is provided with protection for as much of the construction program as is practicable.

Where the natural components within steel reinforced concrete or other encased element are required to be bonded according to the LPS design, prove acceptable continuity of each section and joint prior to the encasement, and after the encasement. Operate a sign-off system, mutually agreed between those involved, the management contractor and the project manager, to ensure adherence to the system of verification. Confirm that acceptable impedance values are achieved pre and post encasement.

Once the system down conductor paths are complete, measure the resistance to verify that they represent a suitably low resistance path to the earth termination network of 0.2 ohms or less.

With its test joint removed, and without any bonding to other services, measure the earth resistance of every individual earth electrode. Ensure such resistance in ohms does not exceed ten times the number of down conductors on the structure.

Measure, with the test links in place but prior to bonding with other services, the resistance to earth of the complete LPS at any point on the building. Ensure that all results from this test do not exceed 10 ohms.

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During the construction of the foundation system measure the earth resistance of every individual foundation element forming an earth electrode, in isolation from all others. Ensure such resistance in ohms does not exceed ten times the number of down conductors on the structure.

Measure the earth resistance of every individual reference earth electrode against the foundation earth, and record the results with those of the foundation earth system.

Once the foundation earth is completed and bonded with the rest of the LPS, measure the resistance to earth of the complete lightning protection system. Ensure that all results from this test do not exceed 10 ohms.

Provide, at no additional cost to the Employer, any means, (eg the addition of earth mats or plate electrodes), as recommended by BS EN 62305, to reduce the overall resistance.

Notify and agree with Employer the cost of additional earth electrodes required to accommodate adverse soil resistivity conditions. Provide at agreed cost the additional earth electrodes to achieve an earth resistance not exceeding 10 ohms.

1030 Documentation

Fully tabulate all test results and issue to the Contract Administrator. Allow for all witnessing of the testing procedure by the Contract Administrator.

Issue a system test certificate detailing compliance with all the relevant British Standards and this specification.

1100 SCHEDULE OF INSTALLER'S SUBMISSIONS

Submit to the Contract Administrator in accordance with Sections A11, A33 and A37 of the project specification:

- ~ soil survey report and earth resistivity measurements
- ~ specialist's lightning protection risk assessment determining protection level
- ~ specialist's design and installation drawings for the entire LPS and SPM clearly showing the location of every component of the system(s) and details of all fixings, including those to building structure, reinforcement of concrete, and building fabric
- ~ samples of all components that are visible after installation
- ~ details and specifications of all surge protection devices (SPDs) to be used within the installation
- ~ installation method statements
- ~ all test results and a test certificate to confirm that the system, as tested, complies fully with the BS EN 62305
- ~ CAD record drawings
- ~ operating and maintenance instructions for inclusion in the project O & M manuals.
- ~ a logbook for inclusion within the project O & M manuals, including full instructions for testing procedures and intervals, and with pages for recording test measurements and results

END OF SECTION W52

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W53 ELECTROMAGNETIC COMPATIBILITY AND SCREENING (EMC)

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W53 ELECTROMAGNETIC COMPATIBILITY AND SCREENING (EMC)

100 PERFORMANCE OBJECTIVES

To ensure that the design and installation of the complete electrical installation is in compliance with The Electromagnetic Compatibility Regulations, together with associated acts, standards and statutory instruments.

To safeguard that the electromagnetic disturbance generated by the selected systems and equipment under all operational conditions, does not exceed a level detrimental to other systems and equipment, allowing all systems and equipment to operate as intended.

To confirm that levels of immunity to electromagnetic disturbance required to enable systems and equipment to operate as intended are met.

To select, locate and arrange all equipment, control and signal systems so that they are segregated from and sufficiently clear of power equipment and cabling to avoid adverse influences.

To ensure that all the selected sub-main power distribution routes are such, that the levels of electromagnetic disturbances (conducted, radiated etc) from the cables and equipment do not create disturbances that affect the operations of other systems and equipment.

To include movement of ferromagnetic sources (such as lifts, escalators, vehicular traffic etc) which can generate quasi-DC magnetic fields and consequently disturb geo-magnetic fields are taken into account when designing systems which require immunity to such fields.

To ensure that Radio Frequency (RF) is taken into account when designing and installing systems that require immunity to such fields.

To undertake all necessary surveys and measurements throughout the frequency spectrum (Quasi-DC, power frequency and its harmonics, RF etc) if required.

To develop an EMC management control plan to manage and control all hazards caused by EMC.

200 DESIGN PARAMETERS

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender and other standards, regulations, codes of practice, etc, not scheduled but relevant to ensuring compliance with The EMC Regulations:

The Electromagnetic Compatibility Regulations

The Radio and Telecommunications Terminal Equipment Regulations

BS 7671	Requirements for electrical installations. IET Wiring Regulations
EN 50121	Railway applications. Electromagnetic compatibility
BS EN 50173	Information technology. Generic cabling systems. Office premises
BS EN 50174	Information technology. Cabling installation. Installation specification and quality assurance
BS EN 50310	Application of equipotential bonding and earthing in buildings with information technology equipment
BS EN 55022	Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement
BS EN 61000 series	Electromagnetic compatibility (EMC). Generic standards
BS EN 62041	Power transformers, power supply units, reactors and similar products. EMC requirements
BS IEC 61000-5	Electromagnetic compatibility (EMC). Installation and mitigation guidelines

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Design and install all systems in accordance with all relevant EMC standards, regulations, etc. for equipment, cabling, accessories, etc, and in accordance with manufacturer's recommendations for the equipment and associated cabling, etc.

300 SYSTEM DESCRIPTION

Undertake an EMC assessment for the whole project consisting of pre-installation surveys, theoretical assessments and post installation surveys is required to ensure that the immunity levels for equipment, rooms/areas and systems are met.

Define the EMC requirements required for the project and demonstrate compliance through good engineering practice, theoretical analysis by modelling and simulation (electromagnetic models), surveys, testing, and EMC risk assessments.

Undertake due diligence during design and installation to minimize EMI and ensure EMC requirements are fully complied with.

Undertake site survey(s) to establish any existing background EMI levels that should be taken into account during the design and installation of the system, and to enable all necessary mitigation measures to minimise its effects to be put in place. Use the pre-installation survey to identify:

- ~ quasi-DC magnetic fields
- ~ power frequency magnetic fields including harmonics
- ~ radio frequency electric fields to determine interference from radio waves, and effects on medical and industrial equipment, cellular mobile telephony, etc

Where necessary to comply with this specification, employ an EMC specialist to undertake all necessary analysis of the EMC compliance requirements for the whole project, and provide all the necessary mitigation measures to ensure compliance with The EMC Regulations. Issue the specialist's report to the Contract Administrator for comment.

Incorporate any mitigation measures recommended by the specialist into the design, prior to the production of the installer's working drawings.

Provide effective shielding to all rooms/equipment as necessary in order to achieve compliance with the required EMC environment.

Install all EMC associated systems in accordance with the manufacturer's recommendations.

Take responsibility for ensuring the whole project complies with the requirements of The EMC Regulations and meet the immunity levels required for rooms/areas, equipment etc. Take the following good engineering practices into account during the design and installation of the systems:

- ~ select locations for initial and future power, data and control cabling, and equipment and their distribution routes, such that they are not adversely affected by electromagnetic interference
- ~ avoid locating critical equipment close to electrical switchrooms
- ~ route power cables in a separate cable containment system from data and control systems cabling
- ~ avoid parallel runs of power and data/control cabling in close proximity wherever possible
- ~ avoid interference by spacing power and data/control cabling in accordance with standards and manufacturer's recommended guidance
- ~ use conduit and trunking systems that conform to IEC 61386
- ~ use cable trays, and ensure that their slots are not perpendicular to the axis of the tray

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- ~ always cross power and data cables at right angles
- ~ where appropriate, screen data and control cabling, and increase separation distances between sources of EMI and affected equipment where required
- ~ keep conductor spacing when using single-core cables as small as possible, and ensure that phase and neutral conductors always follow the same route
- ~ ensure careful coordination for all systems including but not limited to; low voltage and high voltage distribution routes, low voltage switchrooms, transformer substations and supply authority switchrooms, electrical and communications risers, and extra-low voltage systems (*ITC, Fire Alarm, BMS, ELV, voice, access control, etc*)
- ~ select switchboards with middle entry for incoming circuits and two side exits for outgoing cables
- ~ give particular attention to overcoming any adverse effects from transient conditions in the power system, eg motor starting, switching, generator start-up and running, and step-load changes, and select the power system distribution routes to ensure that such transient conditions are minimized

400 EQUIPMENT

410 General

Ensure all items of electrical equipment selected for the project comply with The Electromagnetic Compatibility Regulations, the standards in clause 200, and carry the 'CE' mark.

Provide separate cable containment systems for controls and other signal cabling as described in clause 300.

Make appropriate provisions for all systems likely to be affected by EMC effects including but not limited to the following:

- ~ EMI-sensitive laboratory, hospital and other sensitive equipment
- ~ incoming telecommunication / data network
- ~ BMS system
- ~ ITC installations
- ~ lighting control system
- ~ security, access control and CCTV systems
- ~ fire detection and alarm system
- ~ emergency lighting system

500 SYSTEM INSTALLATION

Adopt good engineering practices during installation so that EMI disturbance coupled into systems will not exceed the systems immunity thresholds.

600 TESTING AND COMMISSIONING

Identify all equipment requiring EMC protection measures, and provide all relevant certification from the manufacturer to demonstrate compliance with the requirements of this specification and the manufacturer's requirements.

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Undertake all necessary verification, testing and analysis where certification is not available or the existing certification does not confirm that the equipment or systems are suitable for the environment.

Where certificate(s) for equipment or systems are available from the manufacturer, and these confirm that the equipment or systems are suitable for the environment, then no further testing or analysis is necessary.

Where equipment deviates from the requirements, prepare an assessment of the impact on system compatibility and undertake all remedial measures to ensure that compatibility is not compromised.

Develop a test plan and procedure(s) for each item of equipment, system or sub-system to cover the requirements for EMC testing to demonstrate compatibility. Submit details to the Contractor Administrator for comment. Undertake all tests in accordance with this agreed methodology.

Undertake EMI survey/site measurements, upon practical completion, taking due account of the actual system electrical loads, to confirm that the final electrical installation is in accordance with the design intent. Notify the Contract Administrator of any variations.

Maintain full records of all testing carried out and the results of the tests. Ensure that EMC information is included in the EMC project file and operating and maintenance instruction manuals.

700 SCHEDULE OF INSTALLER'S SUBMISSIONS

Submit the following for the Contractor Administrator's comment:

- ~ EMC specialist's report
- ~ EMC testing plan(s) and procedure(s) for each item of equipment, system or sub-system
- ~ All information and document required the EMC Project File

END OF SECTION W53

PROJECT RED ELECTRICAL INFRASTRUCTURE

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly, for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

BS 4607	Non-metallic conduits and fittings for electrical installations
BS 4678-2	Cable Trunking Steel underfloor (duct) trunking
BS 4678-4	Cable Trunking. Specification for trunking made of insulating material.
BS 7671	Requirements for electrical installations. IET Wiring Regulations.
BS 8313	Code of practice for accommodation of building services in ducts
BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications. Code of practice
BS EN 1366	Fire resistance tests for service installations. Fire protective systems for cable systems and associated components.
BS EN 10088-3	Stainless steels. Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
BS EN 10143	Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape
BS EN 10346	Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions
BS EN 10143	Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape
BS EN 50085-1	Cable trunking systems and cable ducting systems for electrical installations. General requirements.
BS EN 50085-2-1	Cable trunking systems and cable ducting systems for electrical installations. Cable trunking systems and cable ducting systems intended for mounting on walls and ceilings.
BS EN 50085-2-2	Cable trunking systems and cable ducting systems for electrical installations. Particular requirements for cable trunking systems and cable ducting systems intended for mounting underfloor, flushfloor, or onfloor
BS EN 50085-2-3	Cable trunking systems and cable ducting systems for electrical installations. Particular requirements for slotted cable trunking systems intended for installation in cabinets
BS EN 60423	Conduit systems for cable management. Outside diameters of conduits for electrical installations and threads for conduits and fittings
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

BS EN 61386-1	Conduit systems for cable management. General requirements
BS EN 61386-21	Conduit systems for cable management. Particular requirements. Rigid conduit systems
BS EN 61386-22	Conduit systems for cable management. Particular requirements. Pliable conduit systems
BS EN 61386-23	Conduit systems for cable management. Particular requirements. Flexible conduit systems
BS EN 61386-24	Conduit systems for cable management. Particular requirements. Conduit systems buried underground
BS EN 61386-25	Conduit systems for cable management. Particular requirements. Conduit fixing devices
IET	Guidance Note 1: Selection and Erection

200 GENERAL REQUIREMENTS

Except where otherwise stated in this specification these general requirements will be applicable.

210 Circuit protective conductors (CPCs)

Do not use conduit or trunking as the primary means of CPC medium. Install CPCs and ensure that they are of the same voltage grade and temperature rating as the live conductors of that part of the circuit. Use green and yellow coloured insulation for CPCs as required by BS 7671.

Ensure that all CPCs are electrically continuous and bonded to earth throughout.

Ensure that each circuit has its own CPC emanating from the distribution position and installed in the same trunking/conduit as the live conductors of that circuit.

Ensure that every CPC is sized in accordance with BS 7671.

Identify the CPC clearly on all equipment by a cable marker at the earthing terminal. Fix a label adjacent to the earthing terminal of every equipment box, appliance box and the like, stating 'PROTECTIVE CONDUCTOR – DO NOT DISCONNECT'

220 Enclosure cable capacities

Size all conduit and trunking in accordance with *IET Guidance Note 1: Selection and Erection* to provide the following space factor (sum of cross sectional area of cables / net internal area of conduit or trunking) unless otherwise specified in this section:

- ~ Conduit – space factor not to exceed 35% of net internal cross-sectional area of conduit
- ~ Trunking – space factor not to exceed 45% of net internal cross-sectional area of trunking

Do not use conduit less than 20mm nominal diameter.

Ensure that the internal surfaces and ends of conduit and trunking are kept clear of any protrusions, burrs, sharp edges or other foreign bodies except where allowed for as part of the respective conduit or trunking manufacturer's recommended fittings and use. Do not restrict the cross-sectional area capacity or diminish the smoothness of the trunking and conduit internal surface.

230 Protection against corrosion

Do not place dissimilar metals liable to initiate electrolytic action, or other materials liable to cause mutual or individual deterioration, in contact with each other unless specific arrangements are made to avoid the consequences of such contact.

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MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Ensure that all metallic conduit systems comply with BS EN 60423 and BS EN 61386 and are of the heavy gauge welded seam and screwed pattern. Ensure that all metallic conduit systems are mechanically and electrically continuous and bonded to earth throughout.

Ensure that all metallic trunking systems comply with BS EN 50085, and specifically BS 4678-2 for under-floor trunking systems. Ensure that all metallic trunking systems are mechanically and electrically continuous and bonded to earth throughout.

240 Fire resistance and reaction-to-fire performance

Support conduit and trunking such that they would not be liable to premature collapse in the event of fire.

Do not install containment that has a lesser performance with respect to fire-resistance and reaction-to-fire than the cables contained by it.

Where specified, install non-metallic conduits using conduit manufactured from low smoke zero halogen material.

Install fire barriers as required to meet the project fire strategy and the requirements of the Building Regulations.

Ensure that all containment systems (other than metallic conduit) passing through fire compartments are packed inside and outside with intumescent material, or are otherwise preventative of the passing of fire and smoke. Do not use non-metallic containment systems where passing between fire compartments.

250 Trunking performance standard

Ensure that the trunking system, unless specified otherwise in the Particular Specification, (ie trunking and trunking fittings) meets or exceeds the performance classifications shown in *Table 1 - Trunking performance* and as defined in BS EN 50085 (and cross-referenced to BS 4678 in terms of corrosion protection and impact resistance) unless an alternative performance criterion is explicitly required elsewhere in this section.

Table 1 - Trunking performance

Trunking performance property as defined in BS EN 50085	General areas / zones where higher performance not required. Classification:	Higher performance areas / zones or specific application: Plant areas; kitchens... lighting. Classification:
Resistance to impact	Impact of 2J (Alternatively, BS 4678-4 Class Medium mechanical stress for non-metallic trunking)	Impact of 5J (Alternatively, BS 4678-4 Class Heavy for non-metallic trunking)
Minimum and maximum temperature	-5°C to +90°C	-25°C to +120°C
IP Rating, solid object	3, (IP3X)	5, (IP5X)
IP Rating, water	2, (IPX2)	4, (IPX4, and if non-sheathed cables used) 6, (IPX5, Swimming pools)

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Corrosion protection	Medium inside and outside Stove enamel/electro zinc plate/air drying paint	High inside and outside Hot-Dip Pre-Galvanised to BS EN 10346 and BS EN 10143, or stainless steel. Use in kitchens; plant rooms; tank rooms; ducts buried in ground; external and all internal areas subject to dampness
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Enclose non-sheathed (single insulated) cables in conduit, ducting or trunking in accordance with BS 7671 to provide a degree of protection to IPXXD and IP4X. Ensure covers are removable only with the aid of a tool or other deliberate action.

260 Conduit performance standard

Ensure that the conduit performance classification conforms to the *Table 1 - Performance Classification as per BS EN 61386-1*

Conduit Performance Property	Table 1: Performance Classification as per BS EN 61386-1						
	1	2	3	4	5	6	7
Resistance to compression (N)	V. light (125N)	Light (320N)	Medium (750N)	Heavy (1250N)	V. Heavy (4000N)	-	-
Resistance to impact	V. light	Light	Medium	Heavy	V. Heavy	-	-
Lower temperature range, °C	+5	-5	-15	-25	-45	-	-
Upper temperature range, °C	+60	+90	+105	+120	+150	+250	+400
Resistance to bending	Rigid	Pliable	Pliable / Flexible	Flexible	-	-	-
Electrical characteristics	With electrical continuity characteristics	With electrical insulating characteristics	With electrical continuity & insulating characteristics	-	-	-	-
Protection against the ingress of solid objects (IP coding as per BS EN 60529 in brackets)	-	-	> 2.5mm & greater (IP3X)	> 1.0mm & greater (IP4X)	Dust protected (IP5X)	Dust-tight (IP6X)	-
Protection to the ingress of water	Vertical falling water drops	Drops at 15° (IPX2)	Spray (IPX3)	Splashing (IPX4)	Jets (IPX5)	Powerful jets	Temporary immersion

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MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

(IP coding as per BS EN 60529 in brackets)	(IPX1)					(IPX6)	(IPX7)
Resistance to corrosion	Low inside and outside Example: priming paint (BS EN 61386-1 Class 1.)	Medium inside and outside Example: stove enamel/electro zinc plate/air drying paint (BS EN 61386-1 Class 2.)	Medium inside, high outside Example: Stove enamel inside; sherardizing outside (BS EN 61386-1 Class 3.)	High inside and outside Example: Hot dip zinc coating/sherardizing/stainless steel (BS EN 61386-1 Class 4.)	-	-	-
Tensile strength	V. light (100N)	Light (250N)	Medium (500N)	Heavy (1000N)	V. Heavy (2500N)	-	-
Resistance to flame propagation	Non-flame propagating	Flame propagating	-	-	-	-	-
Suspended load capacity	V. light (20N)	Light (30N)	Medium (150N)	Heavy (450N)	V. Heavy (850N)		

Ensure that the conduit system (ie conduit and conduit fittings) meets or exceeds the performance classifications shown in and as defined in BS EN 61386 unless an alternative performance criterion is specified in the Particular Specification.

Table 2 - Conduit performance

Conduit performance property to BS EN 61386	General areas / zones where higher performance not required. Classification number:	Higher performance areas / zones or specific application: Plant areas; kitchens etc. Classification number:
Resistance to compression and impact	2 (light)	4 (heavy)
Low and high temperature	2 (-5°C to +90°C)	4 (-25°C to +120°C)
IP Rating, solid object	3 (IP3X)	5 (IP5X)
IP Rating, water	2 (IPX2)	4 (IPX4, and if non-sheathed cables used) 6 (IPX5, Swimming pools)
Corrosion protection	2 (medium inside and outside)	4 (high inside and outside)

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

	Example: stove enamel / electro-zinc-plate / air drying paint. (BS EN 61386-1 Class 2)	Example: Hot dip zinc coating / sherardizing / stainless steel Use in kitchens; plant rooms; tank rooms; ducts buried in ground; external and all internal areas subject to dampness (BS EN 61386-1 Class 4)
Suspended load	2 (light)	4 (heavy)

Ensure that the protective coating on conduit and trunking fittings (including saddles, conduit boxes, adaptable boxes) are the same class as that on the conduits to which they are joined.

300 GENERAL INSTALLATION REQUIREMENTS

Except where otherwise stated in this specification comply with these general installation requirements.

310 Safety

Do not use the conduit and cable trunking installation at any time as part of a fall arrest system.

Ensure that the conduit and cable trunking installation is coordinated with any spatial requirements necessary to accommodate all installation and future access requirements.

320 Common installation practice – trunking systems

Do not use trunking in exterior locations.

Use multi-compartment trunking where segregation of cables is required. Ensure that the compartments remain fully segregated throughout the length including the bends, sets and tees.

Ensure trunking routes are mechanically continuous throughout their length. Provide all trunking that crosses a construction movement joint with a sliding coupling, for metallic systems, complete with a flexible protective conductor that ensures equipotential bonding.

Fit removable cable restraining straps into trunking at maximum intervals of 600 mm where trunking covers are fixed on the bottom or side of trunking.

Install drip-proof, close fitting trunking covers along the complete trunking length. Use trunking covers of the same material and protective finish as the trunking. Ensure that the cover is removable over the whole length of the trunking. Where trunking passes through building fabric (including walls and ceilings, etc), provide a short length of fixed cover to form a sleeve extending 25mm beyond each face of the building fabric.

Ensure that each cover is fixed throughout its length, and at each end within the last 50mm of its length.

Do not use self-tapping screws or fixed bridge pieces to hold the cover in position.

Do not use non-metallic trunking for vertical routes of 5m or more, for passing through floors or passing through fire compartment walls. In such locations use bonded metal trunking of the correct classification, with a short length of cover to form a sleeve. Install bagged intumescent material within and around the trunking where it traverses fire compartments or between floors, as required to maintain fire integrity.

Install heat barriers in vertical routes of metallic trunking of 5m or more.

Install insulated pin racks for supporting cables in vertical routes of trunking of 3m or more, and at maximum centres of 2m.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Use the trunking manufacturer's standard fittings, of the same material and protective finish as the trunking. Ensure all changes of direction, terminations and tees, use the trunking manufacturer's fittings, suitably 'gusseted' where necessary, for the largest cables. Do not use site-fabricated fittings unless the situations encountered make the use of manufactured fittings impracticable. Submit sample site-fabricated trunking and obtain the Contract Administrator's prior written agreement to any proposal to use fittings not manufactured by the trunking manufacturer.

Make connections to distribution boards, equipment, panels etc, by using manufactured flanges giving the full trunking capacity, making due allowance for the future installation of cables from spare ways. Join each such flange to its associated trunking permanently, and such that the ingress protection of the trunking system is maintained. Fit appropriate gaskets between the flange and board, etc to maintain the IP rating.

Make each connection between trunking and equipment by means of a brass male bush, a coupling and an internally serrated washer, or a standard flanged coupling.

Where multi-compartment trunking is required, do not pass conduit through one compartment in order to reach another compartment. Provide exposed conduit connections to a multi-compartment trunking via a conduit box mounted on the outside of the trunking. In concealed conduit systems, terminate the recessed conduit boxes immediately behind the appropriate compartment, and feed cables through a bushed hole.

In situations where tees and junctions are to be installed in multi-compartment trunking systems, use multi-compartment fittings of such depth as to ensure suitable pass-over connections.

Use only flush-type covers for all flush trunking. Ensure that all finished edges of the trunking are flush with the adjoining surfaces of the fabric of the building. Ensure that all flush covers are coloured to match the finish of the immediately adjacent surface.

Perform all trunking work in accordance with sound practice and in a competent manner using skilled operatives. Ensure that all trunking is installed neatly (whether directly to a surface, or via a suspension or other support system) and routed horizontally level, vertically plumb, or parallel with the features of the building. Use tools and equipment suitable for the intended purpose.

Do not allow suspensions, fixings or other foreign bodies to intrude into the internal space of any trunking. Use roundhead screws for joining to suspensions or fixings. Remove all burrs from the head of all such screws.

Prior to installing cables in trunking remove all debris and take precautions to prevent further ingress of debris.

330 Common installation practice – conduit systems

331 General

Provide each lighting point, socket outlet, equipment point, etc, with a suitable conduit box securely fixed to the building fabric, that is able to support the weight of the fittings, etc. It is only permissible to solely suspend the luminaire or wiring accessory from the conduit box where the conduit system is of rigid metallic construction, with the conduit box fixed to the conduit system using metallic couplers and bushes as appropriate.

Install conduit from trunking to directly above each luminaire position. Size the conduit for the quantity of cables installed.

Install conduit from trunking to each switch-drop back-box position. Size the conduit to include 25% spare capacity, in addition to a maximum space factor of 35% specified.

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MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Co-ordinate trunking and conduit routes. Allow a minimum of 300mm separation between trunking and cable-basket where running in parallel, and 50mm minimum separation where trunking and cable cross. Cross over at 90 degrees

Plan and install routes so that the crossing of surface-mounted conduits is avoided.

Ensure that the mounting plate of each item of surface-mounted equipment completely covers the recessed box to which it is fitted. Ensure that any cables are correctly bushed and protected against mechanical and electrical damage.

Use countersunk screws only where a countersunk hole is also provided otherwise use roundhead screws in all other cases.

Ensure that each accessory box is securely fixed using a minimum of 2 No. fixings.

Drill and tap holes in metalwork suitable for metal thread screws of 6mm diameter, or larger as required.

332 Concealed

Fix all conduits installed above suspended ceilings to the building fabric at distances to comply with BS 7671, Guidance Note 1. Use saddles, or steel strapping suspensions, or circular steel suspension sets with saddles, or proprietary suspension clips. Do not use suspensions that permit greater than a negligible amount of sideways movement of the conduit in normal service.

Provide conduit that is concealed above plastered or rigidly-constructed false ceilings, with ceiling mounted conduit boxes flush with the finished ceiling surface using extension rings where necessary.

Fix all ceiling-mounted lighting points or pull-cord operated switches independently of the support structure of false ceilings. Provide break-joint rings at all luminaire or ceiling switch points as necessary.

Ensure that all conduits concealed in plastered walls have 12mm minimum cover along their whole length and are routed vertically, not horizontally.

Where partitions and walls are of such a construction that it is not possible to make a normal conduit entry to the flush accessory box, terminate the conduit in a box recessed deep into the wall and use an extension box to achieve a flush finish.

Provide boxes of all types (including adaptable, conduit, draw-in) with an overlapping cover flush with the finished wall or ceiling surface, and coloured to match the finish of the immediately adjacent surface.

Where containment is to be installed within and beneath the surface of a screed:

- ~ Do not allow an installation to proceed that may lead to the premature failure of the screed, or screed-embedded services.
- ~ Install containment with at least 25mm depth of cover over its entire length, increasing the burial depth as dictated by the screed manufacturer and the designer of the building fabric.
- ~ Ensure that the installation layout conforms to the requirements of the screed manufacturer and the designer of the building fabric, with specific attention to requirements regarding the lateral separation between buried services. Gain the specific consent and direction of the building fabric designer where conduits would be installed in parallel with other buried services (including containment), with less than 150mm clear space between each.

Where conduits are to be concealed in concrete, fix them securely to the steel reinforcement and fix conduit boxes to the shuttering.

333 Conduit layout and cable draw-in

Ensure that all conduit systems are of the surface-fixed or the concealed type as appropriate and as detailed in the system section(s) of this specification.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Ensure all lubricants and adhesives used for installation are suitable for the intended purpose and do not cause damage or other deterioration to the installation.

Lay conduits parallel and at equal distance to each other maintaining equal distance throughout all turns and bends.

Wherever possible, locate conduits in inconspicuous areas. Wherever a surface conduit turns through a wall install a back outlet box.

Install inspection boxes in accessible positions having due regard to switch and socket positions, and all aesthetic requirements.

Allow for sufficient draw-in boxes to permit ease of wiring/rewiring and comply with *Table 3 - Distance between draw-in boxes*:

Table 3 - Distance between draw-in boxes

No of right-angled bends	Maximum distance between draw-in boxes (m)
Nil	10
1	10
2	6

For the purpose of this specification, a double-set constitutes the equivalent of 1 No. right-angled bend. Do not use more than two right-angled bends or a 10m length of conduit between draw-in boxes.

Ensure that conduit installation allows for the easy pulling in of cables with minimal risk of cable damage. Rectify all causes of difficult draw-in, replacing all damaged cable as necessary.

Take special care to prevent debris and moisture entering conduit systems (conduit and all fittings). Do not leave ends of conduits or conduit boxes open during building operations; effectively plug open ends and cover conduit boxes, and coat with petroleum jelly. Use only shaped plugs or screwed caps.

Remove all swarf, assembly fluids (eg lubrication, adhesive), other debris and moisture ingress to conduit systems and take steps to prevent further ingress.

Remove all swarf, assembly fluids (eg lubrication, adhesive) and other debris from all external conduit surfaces.

Do not draw in cables until the associated section of the conduit installation is complete and free of all debris and moisture.

Arrange conduits so as to minimise the collection of water from condensation or other sources. Where necessary drill drain holes (3mm diameter) in conduit boxes located at local low points and at any other points required by the Contract Administrator.

340 Flexible conduit

Use only weatherproof flexible conduit in external or continually damp locations.

Use non-metallic flexible conduits of the heavy duty reinforced pattern, and of the same manufacturer, colour and composition as the associated rigid non-metallic conduit installation.

Except where agreed otherwise with the Contract Administrator, make all flexible conduits of a length between 300mm and 1000mm.

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MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Ensure flexible conduits comply with BS EN 61386. Only use such conduits for final connections to equipment in the following locations:

- ~ all equipment subject to vibration, including all electric motors
- ~ all equipment subject to adjustment or that can be withdrawn for maintenance
- ~ thermostats, control sensors, etc not forming part of a piped or ducted system

Do not use non-metallic flexible conduit for final connections to heat-producing equipment. Use only metallic flexible conduit with suitable classification for use. Earth both ends of metallic flexible conduit.

Terminate every non-metallic flexible conduit using the coupling connection produced by, or recommended by, the flexible conduit manufacturer.

Ensure that where non-metallic flexible conduit joins rigid conduit, the rigid conduit is terminated with an appropriate box to receive the flexible conduit.

350 Conduit and trunking support

Support conduit as per *Table 4 - Conduit support spacing* and trunking as per *Table 5 – Trunking support spacing* or in accordance with the manufacturer's recommendations if such recommendations specify a lower distance between supports. Use additional supports where conduit provides support to luminaires and other electrical fixings:

Table 4 - Conduit support spacing

Nominal diameter (d) of conduit in millimetres (mm)	Maximum distance between support (m) for rigid conduit			
	Metallic conduit		Non-metallic conduit	
	Horizontal	Vertical	Horizontal	Vertical
$d \leq 25$	1.75	2.0	1.5	1.75
$25 < d \leq 40$	2.0	2.25	1.75	2.0
$d > 40$	2.25	2.5	2.0	2.0

Table 5 – Trunking support spacing

Cross sectional area (A) of trunking in square millimetres (mm ²)	Maximum distance between support (m) for trunking			
	Metallic trunking		Non-metallic trunking	
	Horizontal	Vertical	Horizontal	Vertical
$300 < A \leq 700$	0.75	1.0	0.5	0.5
$700 < A \leq 1500$	1.25	1.5	0.5	0.5
$1500 < A \leq 2500$	1.75	2.0	1.25	1.25
$2500 < A \leq 5000$	3.0	3.0	1.5	2.0
$A > 5000$	3.0	3.0	1.75	2.0

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Support each bend, set, adaptable box, conduit box, etc, by a conduit fixing equally spaced on each side at 150mm maximum.

Use spacer bar type saddles with 3mm clearance between the conduit and fixing surface on all resistance to corrosion Class 2 installations.

Use distance spacing type saddles with 12mm clearance between the conduit and fixing surface on all resistance to corrosion Class 4 installations.

Secure saddles and boxes by screws of minimum size 30mm x No.8. Use brass or sherardized screws for Class 4 installation.

351 Services Support and Suspension Systems

Comply with section Y93 of this specification.

352 Fixing to building fabric

Comply with section Y90 of this specification.

Do not undermine the fire integrity or acoustic integrity of the building-fabric. In addition to the items of good practice described within the MEP information, also comply with any project-specific detail or requirement with respect to fire stopping and acoustics.

400 STORAGE

Where conduit and trunking is stored for any amount of time prior to installation, ensure that they are stored on racks in dry storage conditions that do not promote corrosion, staining, warping or cracking, or allow other damage and defacement to occur. Dispose of any damaged materials; do not install them.

500 METALLIC CONDUIT AND FITTINGS

510 Metallic conduit

Use only conduits and fittings that are free of mechanical defects and surface rust. Ensure that this condition is maintained on installation.

Unless permitted to remain by the Contract Administrator, replace conduits where the protective coating is damaged, or where the protective coating becomes damaged after installation. If permitted to remain by the Contract Administrator, make good the rust patches by cleaning down to bright metal, priming and re-painting to match the undamaged conduit and subject to the satisfaction of the Contract Administrator.

520 Fittings for metallic conduit

Ensure all fittings are malleable iron conforming to BS EN 60423 and BS EN 61386.

521 Conduit boxes

Use circular malleable iron draw-in boxes at all lighting points, angle boxes, tee boxes, and all junctions having up to four conduits. For all other cases use adaptable boxes of the appropriate protective finish.

Fit every conduit box with a heavy steel cover, secured with brass screws, except where covered with a directly mounted accessory or fitting. Ensure all such covers are oversized, where used as flush inspection points, and have break-joint rings at luminaire and ceiling switch positions. Use standard or deep pattern conduit boxes having spout entry, except where they are loop-in boxes.

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MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Ensure that all loop-in boxes are of the non-screwed entry type.

Ensure that all exterior installations and wet or damp installations use hot-dipped galvanised finish conduit boxes having external fixing lugs, malleable iron covers, machined mating surfaces and, where necessary, appropriate neoprene gaskets.

522 Adaptable boxes

Use adaptable boxes complying with BS EN 61386. For areas that are considered subject to mechanical damage and/or an aggressive environment, install adaptable boxes made of malleable iron or heavy duty steel with welded joints and tapped lugs to receive the cover screws. For all other areas, heavy duty hot-dipped galvanised pressed steel adaptable boxes may be installed.

Provide Class 4 installations located in exterior locations, or in areas that are expected to be wet and/or damp, with adaptable boxes having external lugs, a 3mm drainage hole at the lowest point, and a waterproofing seal between the box and the cover; where they are in other areas, use adaptable boxes that do not have external lugs.

Ensure adaptable boxes used as junction boxes for accommodating permissible cable joints, are of adequate size to receive a fixed porcelain or heat-resisting terminal block capable of withstanding the same temperature range as the cable insulation.

Install cable sweeps and neat connections.

Where necessary, use adaptable boxes having earthed barriers to retain segregation of cables for incompatible circuits (eg low voltage and data communications).

Provide overlap lids on flush installations, that are coloured to match the finish of the immediately adjacent surface.

523 Bushes

Use only brass, male type, long-threaded bushes where loop-in non-screwed entries are provided. Do not use lock nuts and ring bushes.

524 Couplings

Ensure that all couplings are in accordance with BS EN 61386 with protection against corrosion, where applicable.

525 Earthing terminals

Ensure that earthing terminals are provided and securely fixed to all equipment boxes, conduit accessories and adaptable boxes, to which either cables, flexible conduits, equipment or other accessories are mounted and terminated.

526 Serrated washers

Use spring metal, female-type serrated washers.

530 Installation

531 General

Cut all conduit threads 'square' and to the correct length and properly butt. Clean existing threads using appropriate running dies before installation. Do not leave threads exposed except on running couplings. Ream all ends smooth.

Provide conduit connections to trunking, metallic boxes, panels, switchgear, or any item not having a tapped entry (or a tapped entry of 6 mm or less), using long-threaded male brass bushes with a flanged coupling and serrated spring washer. Make connections after removing the paint with a purpose-made tool.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHETSER ROYAL INFIRMARY

Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Use locknuts with running couplings on Class 2 installations only when approved by the Contract Administrator.

Do not use running couplers with locknuts for Class 4 installations; use only manufactured conduit unions.

Form all-site manufactured bends and sets on a proprietary bending machine using the recommended former for the diameter and type of conduit. Use only proprietary fittings where tee, cross, right-angle, loop-in, thru, "U", "H", "Y", terminal or inspection pieces are to be installed in the conduit system

Space conduits at least 150 mm from other services, (including gas, water and steam services), unless otherwise agreed with the Contract Administrator.

Provide all conduits which cross-construction movement joints with at least two 90-degree sets (or more to counter the offset) centred on the joint-line such that movement of the joint is taken up by lateral flexing of the conduit sets.

Ensure that the entire conduit system is electrically continuous throughout, forming a fully bonded system, the whole system being effectively earthed. Cross-bond all exposed conductive containment to any other conductive containment systems, structure and services in the locality. Where conductive containment systems extend to the wiring accessory, ensure that there is continuity between the CPC(s) and the containment system. Carry out earth continuity tests before any conduits are concealed.

532 Concealed installation

Ensure that all conduits that are to be buried in concrete or in floor screed are hot-dipped galvanised. Ensure that all exposed threads of conduit joints are completely coated with zinc-rich paint prior to concreting or screeding.

Ensure that all conduits specified for installation in the ground are of high corrosion protection inside and outside to BS EN 61386-24 (generally equivalent to Class 4 protective finish). Wrap all ground installed conduit with 'half-lap' wrap mastic damp-proof bond tape. Extend such wrapping at least 300 mm beyond the ground emergence point.

600 NON-METALLIC CONDUIT AND FITTINGS

610 Non-metallic conduit

Ensure that all non-metallic conduit complies with BS EN 61386, is rigid, heavy gauge, high impact, non-flame propagating, , free from imperfections, smooth inside and outside.

Ensure that all non-metallic conduits are of the same colour throughout the entire installation.

Ensure that all non-metallic conduit is UV-stable.

620 Fittings for non-metallic conduit

Ensure that all fittings are of the same specification and colour as the conduit to which they are attached and comply with BS EN 61386.

Ensure that standard boxes are circular pattern with push-fit spouts to BS EN 61386 and with lid held in place with brass screws. Ensure all conduit box lids are of the same specification and colour as the conduit system.

Ensure that all boxes used at outlet points for luminaires and ceiling-mounted switches, are heat-resistant, have factory-fitted brass earth terminals, and are reinforced with tapped metal inserts for screws used to secure the cover or the fitting.

Ensure that adaptable boxes are of the same British Standard specification as the conduit and have lids fixed by brass screws. Do not use adaptable boxes smaller than 75mm x 50mm or larger than

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

300mm x 300mm. Where cable joints are permitted or specified, ensure that such boxes are of adequate size to contain the terminal block with sufficient space for making neat connections.

Fix the terminal block to the adaptable box using brass or nylon screws.

Fix concealed non-metallic conduits using saddles of the single-hole, half-clip type.

630 Installation

631 General

Use proprietary conduit adhesive for jointing conduit to couplers, adaptable boxes, etc. Insert square-cut conduits to the full depth of the spout.

Provide conduits terminating in trunking, accessories, or any item not having a smooth bored spout with connections using female plain-to-threaded adaptors, secured by a male bush.

Use male plain-to-threaded adaptors where conduits terminate at tapped conduit entry boxes.

Ensure all bends made on site use only appropriate bending springs. Make the radius of such bends not less than 2.5 times the diameter of the conduit. Make bends only where the ambient temperature is above +10°C. Do not use elbows or tees.

Position expansion joints at maximum intervals of 6m. Install expansion joints in accordance with the manufacturer's recommendations. Ensure that the conduit and expansion joint are correctly aligned and free from binding.

Do not use non-metallic conduits in situations where ambient temperatures are likely to be lower than -5°C or higher than 60°C. If temperatures are likely to be lower than -5°C but not lower than -25°C, then use non-metallic conduit of appropriate temperature rating, as described in BS EN 61386.

Use 2-No. fixings with large washers for conduit boxes supporting luminaires or ceiling-mounted pull switches.

632 Concealed installation

Do not bury non-metallic conduits in floor screed where electromagnetic screening is required.

Make fixings by means of single-hole plastic half-clips. Place these at intervals to comply with BS 7671 and at all changes of direction, to prevent displacement.

633 Surface-mounted installation

Ensure that conduit work complies with *Table 4 - Conduit support spacing* above and uses only appropriate spacer bar saddles.

700 METALLIC CABLE TRUNKING

710 General

Manufacture all metal cable trunking from sheet steel in accordance with BS EN 50085, and BS 4678-2 for under-floor systems.

Use galvanised trunking. Ensure that the trunking emanates from the distribution centres.

Ensure that the trunking is complete with earth links to bond across all joints and utilises only manufacturers' proprietary parts.

Supply the trunking in standard lengths, free from all sharp edges and projections and with each length having a coupling sleeve.

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Y60 CONDUIT AND CABLE TRUNKING ENCLOSURES

Use stove-enamelled or electro-zinc-plated inside and outside in areas having Class 2 conduit installations, and a minimum designation of G275 (to BS EN 10143) of hot-dipped zinc coating in areas having Class 4 conduit installations.

Ensure that the entire trunking system is electrically continuous throughout, forming a fully bonded system, the whole system being effectively earthed. Fit brass continuity links to all trunking joints external to the trunking, using brass bolts and shake-proof washers. Cross-bond all exposed conductive containment to any other conductive containment systems, structure and services in the locality. Where conductive containment systems extend to the wiring accessory, ensure that there is continuity between the CPC(s) and the containment system. Carry out earth continuity tests before any containment systems are concealed.

Protect all cut edges of the trunking with a suitable material to prevent damage to the installed cables.

711 Floor trunking

Install all embedded-in-floor and all flush-in-floor trunking systems complete with segregated compartments, fixed straight and level and in accordance with the trunking manufacturer's installation instructions and with the following:

- ~ Install appropriate floor service outlet boxes, junction boxes, change-of-direction boxes and vertical intersection boxes, to form a complete installation.
- ~ Install floor boxes of the fully adjustable pattern each fitted with the required segregated compartments and with appropriate lids.
- ~ Install power, data and telephone outlets as required.
- ~ Ensure that trunking to be concealed in floor screeds complies with BS 4678-2 and BS EN 50085-2-2. Ensure that no void occurs below trunking lengths and that the routes/boxes are correctly packed. Prevent the ingress of screed or debris into the trunking system.
- ~ Ensure that all floor trunking level alignment is correct and that the desired level is maintained throughout any associated screed laying process.
- ~ Ensure that all underfloor trunking systems are fully re-wireable to all final service outlets. Where wireways only are required, install draw-in wires to suit the particular system(s).

800 NON-METALLIC CABLE TRUNKING

810 General

Ensure that all non-metallic cable trunking complies with BS 4678-4 and BS EN 50085, is of heavy gauge high impact resistance construction, non-flame propagating, is smooth inside and outside, and is fitted with drip-proof lids along the complete trunking length. Do not use plastic trunking or plastic trunking products unless they are constructed using low smoke, halogen-free material.

Ensure that the cover of non-metallic trunking is removable throughout.

Make due allowance for expansion to all fixings and connections as recommended by the trunking manufacturer.

Fix dado / skirting trunking with round head screws with oversized washers at a maximum interval distance of 500mm, and at the top and bottom of the trunking. In addition to regular fixing, install further fixings at all trunking-run ends, within the last 50mm of the trunking length. Fill irregularities between trunking and wall with silicon beading to eliminate gaps.

END OF SECTION Y60

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Y61 HV / LV / ELV CABLES AND WIRING

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc.) of this specification, the standard referred to in the engineering system section prevails.

The Dangerous Substances and Explosive Atmospheres Regulations

Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations

BS 2562	Specification for cable boxes for transformers and reactors
BS 5266	Emergency lighting
BS 5467	Electric cables. Thermosetting insulated, armoured cables for voltages of 600/1000 V and 1900/3300 V
BS 5839	Fire detection and fire alarm systems for buildings. Code of practice for system design, installation, commissioning and maintenance
BS 6004	Electric cables. PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring
BS 6121-1	Mechanical cable glands. Armoured glands. Requirements and test methods
BS 6121-5	Mechanical cable glands. Code of practice for selection, installation and inspection of cable glands and armour glands
BS 6231	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and control gear wiring
BS 6387	Specification for performance requirements for cables required to maintain circuit integrity under fire conditions
BS 6622	Electric cables. Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV. Requirements and test methods
BS 6724	Electric cables. Thermosetting, armoured cables for voltages of 600/1000 V and 1900/3300 V, having low emission of smoke and corrosive gases when affected by fire
BS 7211	Electric cables. Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire
BS 7629-1	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS 7835	Electric cables. Armoured cables with thermosetting insulation for rated voltages from 3.8/6.6 kV to 19/33 kV having low emission of smoke and corrosive gases when affected by fire. Requirements and test methods

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BS 7846	Electric cables. 600/1000 V armoured fire resistant cables having a thermosetting insulation and low emission of smoke and corrosive gases when affected by fire
BS 7889	Electric cables. Thermosetting insulated, unarmoured cables for a voltage of 600/1000 V
BS 8434-1	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with addition of water spray
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with 930°C flame and with water spray
BS 8436	Electric cables. Specification for 300/500 V screened electric cables having low emission of smoke and corrosive gases when affected by fire, for use in walls, partitions and building voids. Multicore cables
BS 8488	Prefabricated wiring systems intended for permanent connection in fixed installations. Specification
BS 8491	Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems
BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications. Code of practice
BS EN 13501-6	Fire classification of construction products and building elements. Classification using data from reaction to fire tests on electric cables
BS EN 50085	Cable trunking systems and cable ducting systems for electrical installations
BS EN 50109	Hand crimping tools
BS EN 50200	Method of test for resistance to fire of unprotected small cables for use in emergency circuits
BS EN 50393	Test methods and requirements for accessories for use on power cables of rated voltage 0,6/1,0 (1,2) kV
BS EN 50399	Common test methods for cables under fire conditions. Heat release and smoke production measurement on cables during flame spread test. Test apparatus, procedures, results
BS EN 50525-1	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). General requirements
BS EN 50525-2-31	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core non-sheathed cables with thermoplastic PVC insulation
BS EN 50525-2-41	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core cables with crosslinked silicone rubber insulation
BS EN 50525-2-42	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables for general applications. Single core non-sheathed cables with crosslinked EVA insulation
BS EN 50525-2-81	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Specific requirements for different types of cables

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BS EN 50525-3-41	Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U). Cables with special fire performance. Single core non-sheathed cables with halogen-free crosslinked insulation, and low emission of smoke
BS EN 50565	Electric cables. Guide to use for cables with a rated voltage not exceeding 450/750 V (U0/U). General guidance
BS EN 50575	Power, control and communication cables. Cables for general applications in construction works subject to reaction to fire requirements
BS EN 60332	Tests on electric and optical fibre cables under fire conditions
BS EN 60332-1-2	Tests on electric and optical fibre cables under fire conditions. Test for vertical flame propagation for a single insulated wire or cable. Procedure for 1 kW pre-mixed flame
BS EN 60684	Flexible insulating sleeving
BS EN 60702-1	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V. Cables
BS EN 60702-2	Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V. Terminations
BS EN 60754	Test on gases evolved during combustion of materials from cables. Determination of the halogen acid gas content
BS EN 61034	Measurement of smoke density of cables burning under defined conditions
BS EN 61386	Conduit systems for cable management
BS EN 61386-24	Conduit systems for cable management. Particular requirements. Conduit systems buried underground
BS EN 61439	Low-voltage switchgear and control gear assemblies
BS EN 61442	Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7,2 kV) up to 36 kV (Um = 42 kV)
BS EN 61534	Powertrack systems
BS EN 61535	Installation couplers intended for permanent connection in fixed installations
BS EN 61914	Cable cleats for electrical installations
BS EN 61984	Connectors. Safety requirements and tests
BS EN 62275	Cable management systems. Cable ties for electrical installations
BS EN 62444	Cable glands for electrical installations
BS IEC 60287-1-1	Electric cables. Calculation of the current rating. Current rating equations (100% load factor) and calculation of losses
IEC 60331-1	Tests for electric cables under fire conditions. Circuit integrity. Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm
IEC 60331-2	Tests for electric cables under fire conditions. Circuit integrity. Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter not exceeding 20 mm
IEC 60331-3	Tests for electric cables under fire conditions. Circuit integrity. Test method for fire with shock at a temperature of at least 830°C for cables of rated voltage up to and including 0,6/1,0 kV tested in a metal enclosure

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ENA TS 09-12	Impregnated paper insulated corrugated aluminium sheathed 6350/11000 volt cable
NJUG	Guidelines on the positioning and colour coding of utilities' apparatus

200 GENERAL

210 Cables

Use only cables that have received product certification from the British Approvals Service for Cables (BASEC) or equivalent third party certification.

For any cable requiring fire resistance, use only products having received certification of their compliance via the LPCB.

Supply and install all cables in compliance with the Construction Product Regulations. Ensure that all cables are compliance marked for the appropriate market; are marked with the appropriate Euroclass code and labelling; and have a suitable Declaration of Performance (DoP) based upon testing and verification by BASEC or another equal and accepted notified body. Provide the DoP to the Contract Administrator for comment in advance of cable procurement.

For all power-system cables (including for small power), installed within buildings, install only cables with a Euroclass of D_{ca}, s1b, d2, a2 or better.

For all telecoms-system cables within the scope of BS 6701 and installed within buildings, install only cables with a Euroclass of C_{ca}, s1b, d2, a2 or better.

Where installed outside of buildings, install only cables with a Euroclass of E_{ca} or better.

Where the term "low smoke zero halogen" (LSZH) or "low smoke and fume" (LSF) is included in the project specifications, this means cables with such performance that when affected by fire, they emit only limited smoke and negligible amounts of corrosive gases. Ensure that any cable specified to have "LSZH" or "LSF" sheath and or insulation, meets the Euroclass minimum performance sub-classes of s1b and a2 for smoke density and corrosive gas emission respectively.

Ensure that all containment and fixings of LSZH cabling is of a type producing low levels of smoke and negligible halogens, such that a coordinated strategy for LSZH materials in the cabling and containment systems is achieved.

Ensure that the neutral conductor of a 4-wire three-phase final or distribution circuit is of equal cross-sectional area to a phase conductor.

For recessed tungsten and fluorescent luminaires or for heat-producing or heat-emitting equipment that have final connections using flexible cables, make the final connections using heat-resisting flexible cables. Where heat-producing/emitting equipment is directly wired, fit heat-resisting sleeving, of temperature rating not less than 185°C, over conductors within electrical equipment.

Determine the appropriate value of current carrying capacity for cables in accordance with BS 7671 and BS IEC 60287-1-1, based on a maximum permissible conductor temperature of 70°C in normal service.

Where a conductor operates at a temperature exceeding 70°C ascertain from the manufacturer that the switchgear, protective devices, accessories, other types of equipment connected to the conductor, and the fabric of the building or other material the cable is touching, is suitable for the resulting temperature at the point of contact.

Do not use any current carrying conductor less than:

- ~ 2.5 mm² for general power applications
- ~ 1.5 mm² for general lighting and fire alarm applications

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~ 0.75 mm² for ELV control and signalling applications

Do not use thermoplastic insulated (PVC) cables if the expected ambient temperature exceeds 50°C. Do not use thermosetting insulated (XLPE) cables if the expected ambient temperature exceeds 70°C. In applications where the ambient temperature exceeds these limits, install heat-resisting cables back to the first switch or distribution board or a termination box that is not in an area with elevated temperature.

Where it is permissible for cables to traverse channel-ways or similar on continuously mounted fluorescent luminaires, ensure that the cable rating is appropriate for the temperature inside the channel or duct by applying the appropriate de-rating factor. Do not use thermoplastic insulated (PVC) cables if the expected temperature exceeds 50°C. Do not use thermosetting insulated (XLPE) cables if the expected temperature exceeds 70°C.

Do not use thermoplastic insulated (PVC) cables for final connections to any appliances containing a heating element or any appliance emitting heat. Wherever a final connection is within flexible conduit, make it using heat-resisting cables. Ensure that the full length of cable installed in flexible conduit is heat resistant from the point of connection of the appliance to that with the fixed wiring system contained by rigid containment.

Ensure cables are not in direct contact with any form of polystyrene used in the building.

Ensure that all cables are installed, straightened, dressed and supported to give a neat and workmanlike installation in accordance with BS 7671.

Ensure wherever practicable, low voltage and extra low voltage cables cross at ninety degrees to each other and such that they do not cause interference or mutual detriment.

Do not install cabling in thermal insulation wherever practicable. Ensure cable routes and fixings are selected to prevent mechanical damage or overheating of the cable during installation or during their use.

Wherever cores less than 4 mm² are terminated in tunnel and similar terminations, double them back on themselves to ensure a good level of contact is achieved. Whenever preparing a cable for connection by stripping insulation from it, ensure that the stripping tool does not damage the conductor. Strip back only so much of the insulation that none of the conductor beyond its termination is exposed, and ensure that the termination compresses only its conductor and not its insulation. Do not use soldered connections or lugs.

Terminate all conductors requiring bolted connections with compression lugs using an automatic compression crimp tool that releases only after obtaining the correct crimp depth. Ensure that the cable, the compression lug, the die used and the crimping tool are all compatible. For small compression lugs, use an appropriate hand-crimping tool to BS EN 50109. Test every crimped termination and every mechanical termination for mechanical soundness immediately after making.

Make all bolted terminations using suitable bolts, nuts and shake-proof washers. Tighten connections to the torque recommended by the equipment manufacturer.

Ensure that all cable joints and connections are electrically and mechanically sound.

For low-voltage cables identify conductors using colours and cable markers in accordance with BS 7671.

Identify all cables using a proprietary alphanumeric marker system manufactured by 'Critchley' or an equal alternative supplier accepted by the Contract Administrator. Identify cable references at both ends of the cable, including individual conductors within the distribution boards and at every floor within risers, and allow for up to fourteen alphanumeric characters. When cable markers with a limited fire hazard (LFH) rating are required, use zero-halogen markers made from self-extinguishing material.

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Arrange cable routes so that cables, hangers, cleats, and the like, do not come into contact with, or in close proximity to, pipe services.

Where cables rise from below the floor, protect them by metal conduit to a height of 300 mm above the floor surface. Increase the height of such protection to 2 m where the cables are exposed to potential mechanical damage.

Ensure that all installation work results in a workmanlike installation consistent with recognised 'good practice' in the industry.

220 Cable ties

Where cable ties are used, comply with BS EN 62275, and use the following minimum classification for cable ties:

- ~ 6.1 according to material: may be metallic, non-metallic or composite depending on the location of the installation
- ~ 6.2 according to minimum loop tensile strength: sufficient to support the mass of the cables and any loads that may be imposed during the installation or any subsequent alteration of the installation and not less than 180 N
- ~ 6.3 according to temperature: maximum temperature not less than 85°C; minimum temperature not higher than -5°C for indoor application and not higher than -15°C for outdoor application
- ~ 6.4 according to the flame application time: not less than 30°seconds
- ~ 6.5 according to environmental influence: for outdoor application, declared by the manufacturer as resistant to UV and, for any metallic component, resistant to atmospheric corrosion

Use cable fixings that, when affected by fire, emit levels of smoke and corrosive gases no greater than the cable that they support.

Support wiring systems such that they will not prematurely collapse in the event of a fire, use only metal cable fixings.

Where final-circuit and other minor-gauge cabling is laid in and is supported by incombustible support components, secure them with zero halogen, self-extinguishing, ultra-violet resistant ties. For all other cabling, use plastic coated metallic cable ties or metallic cable cleats. Do not use wire or similar material for cable ties.

Where a cable is fire resisting, select its fixings to maintain the overall fire performance of the cable installation.

230 Cable cleats

Select cleats of duty to suit the application with the following BS EN 61914 requirements:

- ~ capable of accommodating the size or range of cable bundle diameter without cracking or breaking, or stripping screw threads
- ~ resistant to impact at the minimum declared temperature
- ~ capable of withstanding the lateral load at the maximum declared temperature
- ~ capable of withstanding the axial load at the maximum declared temperature
- ~ resistant to electromechanical forces

Ensure each cleat is to be marked with the manufacturer's logo or trademark and the identification or type.

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Ensure that surfaces of cleats are free from sharp edges and burrs that are likely to damage cables or cause possible injury to the installer.

Avoid excess pressure of cleats and other fixings on cables to prevent deformation of the plastic sheathing. Ensure that non-metallic and composite cable cleats and intermediate restraints have adequate resistance to flame propagation and are able to withstand a 30-second period of exposure to a needle flame in accordance with BS EN 61914.

Where a cable is fire resisting, select its fixings to maintain the overall fire performance of the cable installation.

For single-core SWA cables, use aluminium (non-ferrous) or proprietary plastic cleats / brackets for restraints, as opposed to steel, to reduce the effect of eddy current heating within the cleats / brackets.

240 Cable glands

Select cable glands according to the size, type and profile of the cable. Select cable glands complying with the following standards:

- ~ for non-armoured cable: BS EN 62444. Ensure that the classification of the gland as detailed in 6 Classification is compatible with the cable, the installation, and the intended purpose
- ~ for armoured cable: BS 6121-1 with the gland selection compliant with BS 6121-5. Ensure that the protective connection to earth for the gland is certified to a current at least equal to the maximum expected for the installation
- ~ for mineral insulated cables: BS EN 60702-2
- ~ for high voltage cables: a cable entry as described in BS 2562 fitted with a preparatory gland arrangement that provides the performance of a cable gland detailed in BS EN 62444, but not necessarily including the threaded entry. Ensure that the protective connection to earth for the gland is certified to a current at least equal to the maximum expected for the installation.

Use metallic glands where electrical continuity or high impact resistance is required.

Use non-metallic glands where a lightweight gland is required or to be used with a non-metallic enclosure to avoid the need for a separate earth connection to the part of a metal gland.

Use composite glands where it is necessary to guard against electrolytic and / or chemical attack.

For single-core cables, use non-ferrous glands, as opposed to steel glands, in order to reduce the effect of eddy currents which may cause heat and therefore possible thermal damage to the installation.

Fit cable glands with shrouds. Ensure that glands for flexible cables include an effective cable guard.

Use cable glands, shrouds and all associated components that, when affected by fire, emit levels of smoke and corrosive gases no greater than the associated cable they support.

Where a cable is fire resisting, select the gland to maintain the overall fire performance of the cable installation.

Use a cable gland with inner and outer seals where ingress protection is to be maintained at the point of cable termination.

300 LV CABLES IN CONDUIT AND TRUNKING

310 Cables

Select cable for the method of installation that meets the requirements of the relevant standard referred to in clause Y61.100 or in the relevant 'system' section of this specification. This clause applies primarily to the following:

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- ~ thermosetting insulated non-sheathed single-core cable to BS EN 50525-2-31, harmonised code H07Z-R, cable code 6491B (low smoke zero halogen cable)
- ~ PVC insulated non-sheathed single-core cable to BS EN 50525-2-31, harmonised code H07V-R, cable code 6491X
- ~ heat-resisting rubber insulated non-sheathed single-core cable to BS EN 50525-2-42, harmonised code H07G-R
- ~ heat-resisting silicone-rubber insulated non-sheathed single-core cable to BS EN 50525-2-41, harmonised code H05SJ-K

This clause also applies to insulated and sheathed single-core cables or insulated and sheathed multi-core cables with or without a circuit protective conductor described below when installed in conduit or trunking:

- ~ thermosetting insulated sheathed single-core or multi-core cable to BS 7211, table 3, cable code 6181B, or table 5 cable code 624#B. Use class 2 multi-stranded conductors for cables of 4.0 mm² and above. Use class 1 single-stranded conductors for cables below 4.0 mm² (low smoke zero halogen cable)
- ~ PVC insulated and sheathed single-core or multi-core cable to BS 6004, table 3 or 5, cable code 618#Y or table 4 or 5, cable code 624#Y. Use class 2 multi-stranded conductors for cables of 4.0 mm² and above. Use class 1 single-stranded conductors for cables below 4.0 mm²
- ~ thermosetting insulated PVC sheathed single-core cable to BS 7889, table 3, cable code 6181X
- ~ [In the descriptions above # denotes number of cores.]

This clause also applies to cables of other types where installed in trunking or conduit for support or mechanical protection.

When installing cables within a building or occupied space use only cables that, when affected by fire, emit low levels of smoke and zero halogens (LSZH sheathed multicore and LSZH insulated single core cables), unless specified otherwise in the relevant 'system' section of this specification or on the drawings.

Select cables according to external influences not only for proper functioning, but also to ensure the reliability of the measures of protection for safety in accordance with BS 7671 and BS EN 50565.

Use only new cables with each coil having its manufacturer's seal intact giving the size, classification and the like.

Ensure that the sizes of all cables including circuit protective conductors (CPCs) are in accordance with BS 7671. Design the cable sizing with a grouping correction factor for the actual circuits within the same containment, plus a further factor for not less than 25% additional future circuits.

Where an installation includes an extension or alteration to a pre-existing installation, do not add cables where their installation would result in the grouping correction factor for the total number of circuits reducing the current carrying capacity of the cables below that required by BS 7671.

Where cables are routed outside of their associated trunking for making the final connection to an energy meter, use sheathed and insulated single cables. Ensure that such cables where outside the trunking, are as short as practicable and meet the metering requirements of the supply company. This method of connection is generally applicable only for directly metered supplies of 100 A or less.

320 Installation

Install and fix all cables in accordance with BS EN 50565.

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Install cables only of the same voltage band within the same conduit and trunking system. Do not install cables forming part of a fire alarm and detection system in the same cable containment as other circuits. Install a dedicated cable containment system exclusive to the wiring system serving a Group 2 medical location (as defined in chapter 9 of Guidance Note 7 'Special Locations' published by the IET) where electrical equipment is supplied through a safety-isolating transformer.

Ensure the electromagnetic compatibility of equipment connected with wiring routed within the same conduits and trunking.

Ensure that all conduit and trunking is de-burred and free from sharp edges, water, chemicals, building debris, dust and other contaminants before cables are installed, and throughout the period of the installation works.

Where tungsten luminaires are ceiling-mounted direct to conduit boxes, use heat-resisting cables from the luminaire to its lighting switch and respective neutral conductor.

Carry out all wiring of multi-point circuits in a 'loop-in' system, and do not use joints or connections, other than those required for the connection of switches, fuses, socket outlets, motors and the like.

Do not make cable joints within trunking.

Do not allow cables to exceed the capacity of the conduit and/or trunking as defined in Guidance Note 1 'Selection and Erection of Equipment' published by the IET.

Ensure that the sheathing and insulating materials of cables are not damaged while drawing cables into conduit.

Do not install cables when the temperature is below the minimum installation and handling temperature given in BS EN 50565. If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

In the event of any insulation being damaged, eg while cables are being drawn or laid in, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

Do not bend cables during installation to a smaller radius than the normal-use minimum bending radius specified by the cable manufacturer or BS EN 50565 where the manufacturer data does not exist. Take into account that the minimum bending radius allowed for installation work is within a limited range of ambient temperatures.

Do not draw cables into conduit occupied by cables. If conduits occupied by cables have to be used for additional circuits or alterations, then isolate, identify, label, disconnect and withdraw all wiring from the conduit. Replace the wiring by drawing it back into the conduit with the new wiring.

Do not draw cables into trunking but lay them in, irrespective of whether the trunking is installed 'lid-up', 'lid-down', or 'lid-on-side'. 'Comb' cables as laying-in proceeds and lay the neutral and circuit protective conductor of each circuit with each phase cable of that circuit. Where trunking is installed lid-down, support the cables with proprietary cable retainers at intervals not exceeding 1 m. Ensure that cables are not trapped between the trunking body and its lid or fastening.

Ensure that the respective neutral or switched live conductor and the circuit's permanent live conductor are contained in the same containment section to prevent eddy current heating of the containment.

Where cables of several circuits occupy the same trunking, bind the cables of each individual circuit together at intervals not exceeding 5 m, by labelling ties or other similar means. As a minimum ensure that the ties at each end of the circuit clearly show the circuit reference number.

Leave sufficient slack in the cables at conduit and trunking expansion joints.

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Where cables are left unattended before installing them in conduits or trunking, temporarily form them into coils, bind them and securely support the resulting coils at high level.

330 **Circuit protective conductors (CPCs)**

Do not use conduit or trunking as a CPC medium. Install CPCs and ensure that they are of the same grade and temperature rating as the live conductors of that part of the circuit. Use green/yellow coloured insulation for CPCs in accordance with BS 7671.

Ensure that each circuit has its own CPC emanating from the distribution position and installed in the same trunking/conduit as the live conductors of that circuit.

Ensure that every CPC is sized in accordance with BS 7671.

Identify the CPC on all equipment clearly, by a cable marker at the earthing terminal. Permanently fix in a visible position adjacent to the earthing terminal of every equipment box, appliance box and the like, a durable label to BS 951 indelibly marked with the words "SAFETY ELECTRICAL CONNECTION – DO NOT REMOVE".

400 **INSULATED AND SHEATHED CABLES**

410 **Cables**

Select cable for the method of installation that meets the requirements of the relevant standard referred to in clause Y61.100 or in the relevant 'system' section of this specification. This clause applies primarily to the following:

- ~ thermosetting insulated sheathed single-core or multi-core cable to BS 7211, table 3, cable code 6181B, or table 5 cable code 624#B. Use class 2 multi-stranded conductors for cables of 4.0 mm² and above. Use class 1 single-stranded conductors for cables below 4.0 mm² (low smoke zero halogen cable)
- ~ PVC insulated and sheathed single-core or multi-core cable to BS 6004, table 3 or 5, cable code 618#Y or table 4 or 5, cable code 624#Y. Use class 2 multi-stranded conductors for cables of 4.0 mm² and above. Use class 1 single-stranded conductors for cables below 4.0 mm²
- ~ thermosetting insulated PVC sheathed single-core cable to BS 7889, table 3, cable code 6181X
- ~ [In the descriptions above # denotes number of cores.]

Ensure that the cross-sectional area of the integral circuit protective conductor complies with BS 7671.

Identify conductors using colours in accordance with BS 7671. Fit coloured sleeves over bare copper CPCs, where stripping-back the sheath has exposed them. Fit coloured sleeves to BS EN 60684 where the standard colour of the phase or neutral conductor is at variance with the identification colour given in BS 7671 (for example, when the blue conductor in a two-core cable is used as a switch wire).

420 **Installation**

421 **General installation requirements**

Do not install cables when the temperature is below the minimum installation and handling temperature given in BS EN 50565. If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

In the event of any cable being damaged, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

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Do not bend cables during installation to a smaller radius than the normal-use minimum bending radius specified by the cable manufacturer or BS EN 50565 where the manufacturer data does not exist. Take into account that the minimum bending radius allowed for installation work is within a limited range of ambient temperatures.

Ensure compliance with the requirements of BS EN 50565 in respect of instances where the sheath temperature may exceed 50°C by ensuring that:

- ~ either the cable is located so that persons or animals will not touch it, or
- ~ the cable is de-rated to prevent its temperature from rising above 50°C

Do not bury these cables underground. Only install these cables in external locations if contained within conduits or trunking.

Do not install these cables in locations classified as hazardous areas.

Install and fix all cables in accordance with BS EN 50565 using single-pin or saddle clips. Use clips that, when affected by fire, emit levels of smoke and corrosive gases no greater than the cable that they support. Where cables are supported on cable tray, or supported in other similar ways, fixing of the cables using cable ties is acceptable. Where cables are fixed using cable ties ensure that the rating of the cables is not affected beyond that allowed for by the grouping factors applied.

Support wiring systems such that they will not prematurely collapse in the event of a fire, use only metal cable fixings.

Where final-circuit and other minor-gauge cabling is laid in and is supported by incombustible support components, secure them with zero halogen, self-extinguishing, ultra-violet resistant ties. For all other cabling, use plastic coated metallic cable ties or metallic cable cleats. Do not use wire or similar material for cable ties.

Where cables are supported from a catenary system use only proprietary catenary fixing clips suitable for the environment they are installed in and in accordance with BS 7671.

Where the final circuit cable installation is intended to be installed without containment as in domestic installations using multicore cabling, fix these cables to maximise their capacity by installing multiple bunches of no more than ten cables in any one bunch with heavy loads separated. Install accessory boxes for all terminations and accessories.

Where cables enter boxes ensure that all cable sheaths pass fully into the box via a rubber insert bush and web. In areas where class 4 conduit or trunking is installed (eg in kitchens, plantrooms and areas subject to dampness), use packed glands with neoprene washers in lieu of rubber insert bushes. Within every box ensure that the CPC has sleeving coloured green/yellow in accordance with BS 7671, where connecting to the earthing terminal. Install a separate green/yellow sleeved CPC from the earthing terminal of the box to the earthing terminal of the accessory or appliance.

Do not use these cables for final connections to any heat-emitting appliance nor to any appliance containing any heating element.

Fit heat-resisting sleeving of temperature rating not less than 185°C, over conductors within electrical equipment, including tungsten luminaires where the temperature at the termination may exceed the temperature rating of the cable.

422 Installation requirements for surface installations

Comply fully with clause Y61.421 of this specification.

Install cables as inconspicuously as possible, taking advantage of the features of the building by fixing in corners, along skirting boards, mouldings and the like, and around fittings and the like while maintaining the appropriate bending radius of the cable.

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Where cables are installed in roof spaces or lofts, clip them to the side of joists and rafters. Where traversing between adjacent joists or rafters, install a 'binder-joint' or suitable batten and clip the cable to its side.

423 Installation requirements for concealed installations

Comply fully with clause Y61.421 of this specification.

Protect cables by means of galvanized metal capping where concealed in solid masonry walls.

Where cables are installed in a wall or partition at a depth of less than 50 mm from a surface of the wall or partition, ensure that the cable:

- ~ (i) Is installed in a zone within 150 mm from the top of the wall or partition or within 150 mm of the vertical junction of two adjoining walls. Where a cable is connected to an electrical point, accessory or switchgear on any surface of the wall or partition, install the cable in a zone either horizontally or vertically to the point, accessory or switchgear
- ~ (ii) Incorporates an earthed metallic covering which complies with the requirements for a protective conductor of the circuit, complying with BS 5467, BS 6724, BS 7846, BS 8436 or BS EN 60702, or
- ~ (iii) Is installed in earthed trunking or ducting complying with BS EN 61386 and satisfying the requirements for a protective conductor, or
- ~ (iv) Is enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements for a protective conductor, or
- ~ (v) Is provided with mechanical protection against damage sufficient to prevent penetration of the cable, or
- ~ (vi) Forms part of a Separated Extra-Low Voltage (SELV) or Protective Extra-Low Voltage (PELV) circuit complying with BS 7671

Where clause (i) has been met but neither of the clauses (ii) to (vi) apply to the installation, provide the cable with additional protection by means of a residual current device (RCD) with the characteristics specified within BS 7671.

Ensure that, irrespective of its buried depth, a cable in a wall or partition with metallic parts, other than fixings such as nails, screws and the like (for example, a metal stud frame):

- ~ is provided with additional protection by means of an RCD, or
- ~ complies with the requirements within BS 7671 for a cable installed at a depth of less than 50 mm

Where cables are routed through joists, drill through the neutral axis of each joist perpendicular to its surface, ensuring that there is at least 50 mm of joist above and below the hole. Do not notch joists.

Terminate all lighting points in a ceiling rose box mounted flush to the ceiling. Ensure that every such box is of heavy-gauge, self-extinguishing PVC to the relevant British Standard, reinforced with tapped metal inserts.

Do not lay cables directly on suspended ceilings. Where groups of cables are routed above suspended ceilings, clip them directly to the soffit or secure them to cable trays (or similar containment). Where single cables are routed above suspended ceilings, secure them to a catenary wire or route them through a length of rigid suspended conduit bushed at both ends. Secure sheathed multi-core flexible cables connecting electrical equipment fixed in the ceiling void (eg fan-coil units) or recessed into the suspended ceiling (eg luminaires), in a similar manner.

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Where sheathed multi-core flexible cables are used to make final connections to electrical equipment and luminaires, ensure that cord-grips are used at both ends to secure the sheath of the cable in order to prevent strain on the conductors.

500 FIRE-RESISTING CABLES FOR VOICE ALARM AND FIRE ALARM SYSTEMS

510 Cables and cable systems

For public address systems that are used for announcing the evacuation of a building (including voice alarm systems), emergency voice communication (EVC) systems and for fire detection and alarm systems, use fire-resisting cable systems of 'standard fire resistance' (PH30) or 'enhanced fire resistance' (PH120) as required by the appropriate part(s) of BS 5839 and as defined by the testing regimes of BS 8434 and BS EN 50200.

Use one or more of the following wiring systems:

- ~ mineral insulated cable systems complying with BS EN 60702-1 and BS EN 60702-2 and BS EN 60332-1-2
- ~ fire-resistant cables complying with IEC 60331-1 or IEC 60331-2 or IEC 60331-3 and with BS EN 60332-1-2
- ~ fire-resistant cables complying with test requirements of BS EN 50200 or BS 8434 or BS 8491, appropriate for the cable size and with BS EN 60332-1-2
- ~ a wiring system maintaining the necessary fire and mechanical protection

Select the wiring system to meet the requirements of the appropriate part(s) of BS 5839 relative to the application, and install in such a way that the circuit integrity will not be impaired during a fire.

Install cabling of minimum fire survival time as required by BS 8519 and to the requirements of the specific system for which the cable is being used. Mechanically protect the cabling either by the cable's own armoring or additional enclosures.

Use clips that emit levels of smoke and corrosive gases when affected by fire no greater than the cable that they support.

Ensure that all accessories, including, but not limited to fixings, supports, terminations, terminals and glands are compatible with the cable selected, and together with the cable containment and supports form a cabling system that meets the required integrity standard. Produce documentary evidence and technical information that demonstrates that the cable system as a whole is consistent in its fire-resistance rating. Ensure that such documentation is incorporated in the building health and safety file and forms part of the relevant operation and maintenance instruction manuals.

Other than for instances prohibited in clause Y61.520 or otherwise specified in the relevant 'system' section of this specification, or otherwise shown on the drawings, flexible soft-skin cables are acceptable.

Obtain written assurance from the manufacturer of the fire alarm, voice alarm and EVC systems installed, that the proposed cabling system is compatible with the fire alarm, voice alarm or EVC system. Ensure that the assurance documentation is incorporated in the building health and safety file and forms part of the relevant operation and maintenance instruction manuals.

520 Installation

Install fire-resisting cables in accordance with BS EN50565, BS 5839 and the cable manufacturer's guidance. Fix fire-resisting cables to fire-resisting structure and secure with fire-resisting fixings.

Where there is risk of damage by rodents, use armoured cable or install the cable within steel conduit.

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Do not install cables when the temperature is below the minimum installation and handling temperature given in BS EN 50565. If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

In the event of any cable being damaged, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

Do not bend cables during installation to a smaller radius than the normal-use minimum bending radius specified by the cable manufacturer or BS EN 50565 where the manufacturer data does not exist. Take into account that the minimum bending radius allowed for installation work is within a limited range of ambient temperatures.

Do not bury flexible soft-skin cables underground.

Do not install flexible soft-skin cables in locations classified as hazardous areas unless appropriate certification exists for the cable and installation.

For surface installations install cables as inconspicuously as possible, taking advantage of the features of the building by fixing in corners, along skirting boards, mouldings and the like, and around fittings and the like while maintaining the appropriate bending radius of the cable.

Protect cables by means of galvanized metal capping where concealed in solid masonry walls. Where cables are routed in hollow partitions ensure they are mechanically protected by virtue of their position or otherwise by metallic conduit. Ensure that cables installed in hollow partitions are arranged in such a way that they are effectively supported.

Where cables are concealed within solid walls or partitions, route them vertically in the zone directly above or below the accessory they serve. Do not install horizontal cabling to or from accessories.

Where cables are routed through joists, drill through the neutral axis of each joist perpendicular to its surface, ensuring that there is at least 50 mm of joist above and below the hole. Do not notch joists.

Do not lay cables directly on suspended ceilings. Where groups of cables are routed above suspended ceilings, clip them directly to the soffit or secure them to cable trays (or similar containment). Where single cables are routed above suspended ceilings, secure them to a catenary wire or route them through a length of rigid suspended conduit bushed at both ends.

600 FIRE-RESISTING CABLES FOR GENERAL APPLICATIONS

610 Cables and cable systems

Where wiring and interconnection is required to maintain circuit integrity under fire conditions for longer periods than can be achieved with cables of conventional construction, use one or more of the following wiring systems:

- ~ mineral insulated cable systems complying with BS EN 60702-1 and BS EN 60702-2 and BS EN 60332-1-2
- ~ fire-resistant cables complying with IEC 60331-1 or IEC 60331-2 or IEC 60331-3 and with BS EN 60332-1-2
- ~ fire-resistant cables complying with test requirements of BS EN 50200 or BS 8434 or BS 8491, appropriate for the cable size and with BS EN 60332-1-2
- ~ a wiring system maintaining the necessary fire and mechanical protection

Select the wiring system to meet the requirements of the appropriate part(s) of BS 5266 or BS 8519 relative to the application, and install in such a way that the circuit integrity will not be impaired during

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a fire, with the cable support system achieving a level of fire resistance via suitably sized suspension rods as calculable according to Annex E of BS 8519.

Install cabling of minimum fire survival time as required by BS 8519 and to the requirements of the specific system for which the cable is being used. Mechanically protect the cabling either by the cable's own armoring or additional enclosures.

Where the cable itself cannot achieve the required fire rating such as for high and medium voltage distribution, it is acceptable to install non-fire resistant cabling within fire resistant enclosure(s) meeting the minimum fire survival time published in BS 8519.

For control and bus systems of safety services, use wiring meeting the same requirements as the wiring used for the safety services in question, except for circuits thereof that do not adversely affect the operation of the safety equipment.

Use clips that emit levels of smoke and corrosive gases when affected by fire no greater than the cable that they support.

620 Installation

Install fire-resisting cables in accordance with BS EN 50565, BS 8519 and the cable manufacturer's guidance. Fix fire-resisting cables to fire-resisting structure and secure with fire-resisting fixings.

Where there is risk of damage by rodents, use armoured cable or install the cable within steel conduit.

Do not install cables when the temperature is below the minimum installation and handling temperature given in BS EN 50565. If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

In the event of any cable being damaged, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

Do not bend cables during installation to a smaller radius than the normal-use minimum bending radius specified by the cable manufacturer or BS EN 50565 where the manufacturer data does not exist. Take into account that the minimum bending radius allowed for installation work is within a limited range of ambient temperatures.

Do not bury flexible soft-skin cables underground.

Do not install flexible soft-skin cables in locations classified as hazardous areas unless appropriate certification exists for the cable and installation.

For surface installations install cables as inconspicuously as possible, taking advantage of the features of the building by fixing in corners, along skirting boards, mouldings and the like, and around fittings and the like while maintaining the appropriate bending radius of the cable.

Protect cables by means of galvanized metal capping where concealed in solid masonry walls. Where cables are routed in hollow partitions ensure they are mechanically protected by virtue of their position or otherwise by metallic conduit. Ensure that cables installed in hollow partitions are arranged in such a way that they are effectively supported.

Where cables are concealed within solid walls or partitions, route them vertically in the zone directly above or below the accessory they serve. Do not install horizontal cabling to or from accessories.

Where cables are routed through joists, drill through the neutral axis of each joist perpendicular to its surface, ensuring that there is at least 50 mm of joist above and below the hole. Do not notch joists.

Do not lay cables directly on suspended ceilings. Where groups of cables are routed above suspended ceilings, clip them directly to the soffit or secure them to cable trays (or similar containment). Where

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single cables are routed above suspended ceilings, secure them to a catenary wire or route them through a length of rigid suspended conduit bushed at both ends.

700 MINERAL INSULATED, COPPER COVERED (MICC) CABLES

710 Cables

Use only cables that comply with BS EN 60702-1.

Use mineral insulated cables with copper conductors, mineral insulation (inorganic type), copper sheaths and a halogen free outer covering, unless specified otherwise in the relevant 'system' section of this specification or on the drawings.

Do not use cables of less than 1.5 mm².

For MICC cables within fire detection and alarm systems, use a red coloured outer sheath and ensure that this colour of sheath is not used for any other application in the same building.

Use 300/500-V or greater grade for:

- ~ socket outlet circuits
- ~ lighting circuits except discharge lighting
- ~ fire alarm systems
- ~ call systems
- ~ reduced low voltage systems

Unless otherwise specified in the relevant 'system' section of this specification, use 750-V grade for:

- ~ motor wiring
- ~ 400 V 3- or 4-wire circuits
- ~ discharge lighting circuits

720 Terminations

Ensure the equipment for terminating MICC cables complies fully with BS EN 60702-2 and is of the same manufacture as the cable.

Select cables seals complying with the following:

- ~ installations up to 105°C - cold screw-on pot type, sealed with plastic compound or alternatively, 'shrink-on' type sealed by the application of heat
- ~ installations between 105°C and 185°C - cold screw-on pot type, sealed with suitable plastic compound and bonded glass-fibre caps or, alternatively, 'shrink-on' type sealed by the application of heat

Within 24 hours after sealing both ends of each MICC cable make a 500-V dc (Megger) insulation resistance test of each seal to prove an infinity reading.

Ensure that all terminations on surface installations have brass compression glands conforming to BS EN 60702 and are fitted with shrouds. In areas where installations are concealed within the fabric of walls and the like, use proprietary MICC clamps to the conduits and adaptable boxes.

Use proprietary male/female cable gland arrangements where cables terminate in plain-hole boxes.

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Where glands are omitted or, where the termination is made into a non-metallic enclosure, provide patent CPC tails with the protective conductor brazed to each pot by the manufacturer and suitably sleeved.

Insulate cable tails with sleeving to suit the prevailing temperature conditions. Use sleeving for tungsten luminaires of the medium temperature range for use up to 185°C.

Apply colour-coded markers to the sleeving of phase and neutral conductors in accordance with BS 7671. Ensure that CPC tails have green/yellow striped sleeving. Ensure that all such sleeving is anchored and sealed to the pot.

Where MICC cables are used in hazardous areas (ie where gases, vapours or dust present a risk of explosion), terminate them with glands and seals that have been certified for use in the hazardous area. Use a type of termination that is compatible with the electrical installation in the hazardous area (eg flameproof, intrinsically safe, etc). Ensure that the certification meets the current ATEX standards, eg ATEX 95 (Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations) and ATEX 137 (Dangerous Substances and Explosive Atmospheres Regulations), and include a copy of the certification in the operating and maintenance instruction manuals.

Ensure the environmental conditions when making terminations are such that the work can be carried out without detriment to the completed termination.

730 Conduit boxes and adaptable boxes

Use conduit boxes for terminating or jointing MICC cables with a class 4 protective finish to BS EN 61386. Install conduit boxes of the 'terminal', 'through', 'tee', or 'crossing' circular patterns for all lighting points. Use steel boxes with lugs suitably tapped to receive brass cover fixing screws (not self-tapping). Fit a heavy steel cover to each box, unless an accessory or fitting is mounted.

Where boxes are in exterior locations or in areas of continual dampness, use conduit boxes or adaptable boxes having external lugs and a waterproofing seal between the box and the cover; and where they are in other areas, use adaptable boxes that do not have external lugs.

Where used as junction boxes for permissible cable joints, use conduit boxes and adaptable boxes having terminal blocks supplied and fixed. Ensure terminal blocks have brass connectors shrouded in porcelain or heat-resisting material capable of withstanding, without deterioration, the same temperatures as the pots, insulation and sleeving. Size boxes to allow for the terminal block and to facilitate neat connections.

Ensure all conduits, accessories, or adaptable boxes, to which flexible cables, or flexible conduits are fitted, or upon which accessories or equipment are mounted, have earthing terminals that are securely fixed to the box.

740 Installation

Install all MICC cables in accordance with BS EN 50565.

Ensure that MICC cables are installed only by experienced installers who have received a course of instruction on the handling, jointing and termination of MICC cables, and in the use of the specialist tools recommended by the cable manufacturer.

Where MICC cables are buried underground, comply with the requirements of the relevant clause of the Y61 specification.

Secure MICC cables using copper saddles with a halogen-free covering, meeting the same performance requirements as the cable outer covering, using 30 mm x 4 mm diameter, roundhead brass fixing screws. Use multiple saddles where several cables are installed together. Where cables are specified with no outer covering, use copper saddles with no covering.

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Ensure the maximum spacing of supports for MICC cables in accessible positions complies with the recommendations of the manufacturer and in any case do not exceed the following:

Overall diameter of MICC cable	Maximum horizontal spacing	Maximum vertical spacing
below 9 mm	600 mm	800 mm
9 mm to 15 mm	900 mm	1200 mm
over 15 mm	1500 mm	2000 mm

Where MICC cables are concealed in masonry walls, fix them securely in position before the wall is plastered or rendered. Where cables are routed in hollow partitions, ensure they are mechanically protected by virtue of their position or otherwise by metallic conduit. Ensure that cables installed in hollow partitions are installed in such a way that they are effectively supported.

Where MICC cables are concealed within solid walls or partitions, route them vertically in the zone directly above or below the accessory they serve. Do not install horizontal cabling to or from accessories.

Where surface-mounted equipment is installed within a concealed MICC installation, terminate cables in a flush-mounted box, drill and bush the back of the equipment for back entry, and install the equipment over the box to conceal it.

For surface installations, install MICC cables neatly on the surface and route cables truly horizontal, vertical or parallel with the features of the building.

Where MICC cables are laid in floor screeds, plan routes to avoid areas where there is a possibility of floor fixings. Avoid centres and edges of doorways to allow for fixing closure bolts and the like. Keep cable crossovers within floor screeds to a minimum and maintain a screed cover of 25 mm above cables.

Ensure that MICC cables fixed to galvanized cable tray have an outer covering. Fix saddles using brass roundhead screws, washers and nuts.

Make connections to items of equipment subject to vibration, adjustment or withdrawal, by terminating MICC cables in an appropriate adaptable box, sited adjacent to the item being connected. Enclose the final connection from the box in metallic flexible conduit or install a 360° loop not less than 150 mm diameter immediately adjacent to the cable entry to the equipment. Allow a clear space of not less than 10 mm at the point where the cable crosses itself.

Ensure all cables are installed, straightened and suitably dressed with rollers and the like, to give a neat and workmanlike installation. Ensure that there is no damage to the cable sheath or outer covering. In the event of any cable being damaged, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

At termination positions, arrange cable conductors to minimize crossing.

Fit surge suppressors to all cable ends connected to motors with star connection up to and including 2 kW size.

Segregate MICC cables used for a fire alarm installation, from all other cable categories, by providing separate containment.

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800 ARMoured Cables – Low Voltage

810 Cables

Use cables having class 2 stranded copper conductors, unless specified otherwise in the relevant 'system' section of this specification or on the drawings.

The following abbreviations apply:

- ~ "XLPE/SWA/LSZH" indicates; XLPE compound insulation, polymeric material bedding, single steel-wire armouring, black low smoke zero halogen sheath overall, 600/1000-V grade in accordance with BS 6724
- ~ "XLPE/AWA/LSZH" indicates; XLPE compound insulation, polymeric material bedding, single aluminium-wire armouring, black low smoke zero halogen sheath overall, 600/1000-V grade in accordance with BS 6724
- ~ "XLPE/SWA/LSZH/FR/F#" where # is either 2, 30, 60 or 120 indicates; XLPE compound insulation, polymeric material bedding, single steel-wire armouring, black low smoke zero halogen sheath overall, 600/1000-V grade fire-resisting cable in accordance with BS 7846. F# indicates the category of fire resistance as given in BS 7846 and in the absence of the inclusion of this designation use F120 cable.
- ~ "XLPE/SWA/PVC" indicates; XLPE compound insulation, polymeric material bedding, single steel-wire armouring, black PVC sheath overall, 600/1000-V grade in accordance with BS 5467
- ~ "XLPE/AWA/PVC" indicates; XLPE compound insulation, polymeric material bedding, single aluminium-wire armouring, black PVC sheath overall, 600/1000-V grade in accordance with BS 5467

Use only cables that, when affected by fire, emit low levels of smoke and zero halogens (LSZH sheathed multicore and LSZH insulated single core cables), unless specified otherwise in the relevant 'system' section of this specification or on the drawings.

Where cable sizes are not detailed then size these in accordance with BS 7671 and in addition, those standards pertinent to the installation and load supplied.

Ensure all cables are of the same manufacture and delivered to site in continuous lengths, complete with end caps.

At the manufacturer's works, subject all cables to the routine tests detailed in the relevant British Standards. Submit duplicate copies of test certificates to the Contract Administrator.

For every single-core cable operating on ac systems, use armouring that is non-magnetic (ie is not steel).

820 Terminations, straight joints, tees and branches

Make all cable joints using a proprietary cast-resin kit system, cold-shrink system or heat-shrink joint system supplied by one manufacturer and install strictly in accordance with its instructions. Prior to selecting heat-shrink technology, demonstrate that the installation practices to be adopted make the potential risks associated with hazards negligible (eg applied heat, fire hazards, escaping flammable gas and exposure to fumes).

Install mechanical protection for the cable joint (in the case of a cast-resin joint kit the encapsulation is considered to provide this). For shrink joints, use a further encapsulation where buried or on cable tray or similar arrangement, and cover the joint with a metal tray or equivalent.

Make connections at joints using connectors designed for LV applications, and correctly sized for the type and size of conductor. Connections may use either compression tooling or be of the shear-bolt

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type. For compression connectors use a compression tool that does not release until the correct compression has been achieved, and ensure compatibility between the tool, die and connector. Verify that the continuity resistance of the jointed conductors is no greater than that of the equivalent length of a conductor without a joint, and that the insulation resistance between cores, and between cores and earth, is no less than that of the original cable.

At joints use solder-less earthing connections comprising a constant-force spring and earthing connection for the armour connections. Ensure that the conductivity and fault current capability of the earth connection across the joint is at least equal to that of the cable without the joint.

Fit cable glands complying with BS 6121-1 at all terminations. Select glands in accordance with BS 6121-5. Use brass compression glands for steel-wire armoured cables and aluminium alloy glands suitable for accepting an insulated insert for single-core aluminium-wire armoured cables. Use non-ferrous gland plates for single-core cables. Ensure that all glands have cone grip armour clamps with suitable provision for cross-joint bonding.

Where armoured cables are used in hazardous areas (ie where gases, vapours or dust present a risk of explosion), terminate them with glands and seals that have been certified for use in the hazardous area. Use a type of termination that is compatible with the electrical installation in the hazardous area (eg flameproof, intrinsically safe, etc). Ensure that the certification meets the current ATEX standards, eg ATEX 95 (Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations) and ATEX 137 (Dangerous Substances and Explosive Atmospheres Regulations), and include a copy of the certification in the operating and maintenance instruction manuals.

Ensure the environmental conditions when jointing or terminating cables are such that the work can be carried out without detriment to the completed joint or termination.

830 Installation

Where cables are buried underground, comply with the requirements of the relevant clause of the Y61 specification.

Do not install cables when the temperature is below the higher of:

- ~ the minimum installation and handling temperature specified in the installation recommendations appendix of the appropriate cable standard, or
- ~ the minimum installation and handling temperature given by the cable manufacturer

If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

Do not bend cables to a radius smaller than the larger of:

- ~ the minimum installation radius specified in the installation recommendations appendix of the appropriate cable standard
- ~ the minimum installation radius given by the cable manufacturer

Where cables need to be pulled by winches or use similar mechanical aids, use them fully in accordance with the cable manufacturer's instructions. Record the pulling tension and do not exceed the allowable maximum for the method by which the winch is attached to the cable.

Ensure cables, wherever installed including those fixed on walls or installed in accessible ducts, are fixed at intervals to prevent sag, in accordance with the manufacturer's recommendations. Ensure bends are fully supported.

Fix cables, including those in building engineering services ducts, using cable cleats complying with clause Y61.240 of this specification and galvanized bolts where:

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- ~ the cable is rated as clipped direct (Reference method C (20) of BS 7671)
- ~ the cable is rated as on perforated trays with the cables in a group spaced (Reference method E or F (31) of BS 7671)
- ~ the cable is rated as in trenches (Reference method B (54 or 56) of BS 7671)

Note that the rating of cables is based on cables in a group being spaced, unless otherwise specifically indicated.

Fix cleats so that the maximum spacing between supports does not exceed the lower spacing of those recommended by the manufacturer of the cable and the cleat. In selecting the cleat and fixing, take into account the full details of the installation including the static load of the cable and any load imposed by, but not limited to, wind, icing and the load for wind including icing.

Ensure the maximum spacing of supports for armoured cables in accessible positions complies with the recommendations of the manufacturer and in any case do not exceed the following:

Overall diameter of the cable	Maximum horizontal spacing	Maximum vertical spacing
9 mm to 15 mm	350 mm	450 mm
15 mm to 20 mm	400 mm	550 mm
20 mm to 40 mm	450 mm	600 mm

When the selection takes into account the full details of the installation including the static load of the cable and any load imposed as described above, the fixing may use plastic covered, galvanized, perforated steel strip and galvanized bolts where:

- ~ the cable is rated as clipped direct with the cables in a group touching (Reference method C (20) of BS 7671)
- ~ the cable is rated as on perforated trays with the cables in a group touching (Reference method E or F (31) of BS 7671)

Ensure the material used for cleats, any covering on a metal cleat and the plastic covering of any strip fixing has properties in a fire condition at least equal to that of the cable.

Where the cable is fire resisting, select the fixing so that the overall fire performance of the cable installation is maintained.

Avoid excess pressure of cleats and other fixings on cables to prevent deformation of the plastic sheathing. Install suitable supporting steelwork and/or galvanized cable tray where cables cross open spaces. Protect such steelwork by a rust-inhibiting paint.

Unless specified otherwise in the relevant 'system' section or Y63 of this specification or on the drawings, arrange the installation of single core cables neatly in close trefoil using cable cleats and intermediate restraints complying with clause Y61.230 of this specification.

Install fixings at intervals compliant with the cleating system certification for a maximum fault current at least equal to that of the installation. Install the neutral conductor adjacent to the group and fix in a similar manner. When approaching terminations, ensure the cores remain in close trefoil for as long a distance as possible, keeping the splayed length to the minimum that practical considerations will permit, having regard to minimum bending radii. Where single-core cables are installed with more than one cable per phase, cleat the cables in three-phase groups with the neutral alongside each group using cleats as described above.

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Where single-core cables are specifically detailed to have a flat spaced installation, arrange them neatly at the required spacing fixed to a non-magnetic cleating system otherwise as described above for cables in trefoil. Install fixings at intervals compliant with the cleating system certification for a maximum fault current at least equal to that of the installation. Install the neutral conductor adjacent to the group fixed in a similar manner. Where single core cables are installed with more than one cable per phase, cleat the cables in three-phase groups as described in Y63, using cleats as described above.

Fix cables laid in racks, hangers or on steelwork at intervals to prevent sag, in accordance with BS 7671.

Ensure the armouring is independently bonded to the switchgear and at termination points, using the brass earth “banjo” tag of the gland and single green/yellow cable. Ensure the armouring is bonded for continuity at all points. Use copper conductors of the correct size in accordance with BS 7671.

Where cables pass through walls and floors fit them with permanently fixed oversized sleeves each packed with fire resisting infill. Ensure where cables rise or fall on walls they are protected to a height of 2 m with a sheet steel guard where prone to mechanical damage.

Ensure all cables are installed, straightened and dressed to give a neat and workmanlike installation.

Where armoured cables are installed or terminated into electrical equipment in hazardous areas ensure that a sealed gland with ATEX certification is used of the correct size and type for the cable and the equipment into which it is installed. Ensure that the gland is correctly rated for the gas group of the particular gas or vapour. Where solvent vapours are present ensure that the sheath of the cable and the gland material will not be degraded.

900 CABLES FOR HIGH VOLTAGE APPLICATIONS

For single-core and three-core cables with system nominal voltages from 3.8/6.6 kV up to 19/33 kV inclusive, use cables with:

- ~ stranded copper, stranded aluminium or solid aluminium conductor(s)
- ~ cross-linked polyethylene or cross-linked ethylene-propylene rubber insulation
- ~ metallic armour of aluminium or galvanized steel wire
- ~ thermoplastic over sheath

910 Cables

Ensure that the external surface of each cable is marked with the following elements in accordance with BS 5467, BS 6724, BS 6622 and BS 7835:

- ~ cable manufacturer – manufacturer’s name and unique factory identifier
- ~ electric cable – marked ‘ELECTRIC CABLE’
- ~ voltage designation, eg 6600 V, 11000 V, 33000 V
- ~ manufacturing standard number, eg BS 5467
- ~ number of cores, type, and nominal cross-sectional area of the conductors
- ~ year of manufacture
- ~ mark of a third-party approval organisation, eg BASEC
- ~ standard core colour identifier, ie H

Ensure that the marking of the above elements is by embossing or indenting on the sheath.

Use low-smoke zero-halogen (LSZH) sheaths for cables in enclosed areas and in public spaces.

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Use cables as indicated in the relevant 'system' section of this specification or on the drawings.

The following abbreviations apply:

- ~ "Cu/XLPE/SWA/LSZH" indicates; copper conductors, XLPE compound insulation, single steel-wire armouring, red LSZH compound sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 7835
- ~ "Cu/XLPE/AWA/LSZH" indicates; copper conductors, XLPE compound insulation, single aluminium-wire armouring, red LSZH compound sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 7835
- ~ "Cu/XLPE/SWA/PVC" indicates; copper conductors, XLPE compound insulation, single steel-wire armouring, red PVC sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 6622
- ~ "Cu/XLPE/AWA/PVC" indicates; copper conductors, XLPE compound insulation, single aluminium-wire armouring, red PVC sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 6622
- ~ "Cu/XLPE/SWA/PE" indicates; copper conductors, XLPE compound insulation, single steel-wire armouring, red MDPE sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 6622
- ~ "Cu/XLPE/AWA/PE" indicates; copper conductors, XLPE compound insulation, single-aluminium wire armouring, red MDPE sheath overall, 3.8/6.6 kV to 19/33 kV voltage designation in accordance with BS 6622
- ~ "PICAS" indicates a three-core utility cable with stranded aluminium conductors, belted paper insulation, corrugated aluminium sheath, red PVC sheath overall, 6.35/11 kV voltage designation in accordance with the Energy Networks Association specification ENA TS 09-12

When installing cables within a building or occupied space use only cables that, when affected by fire, emit low levels of smoke and zero halogens (LSZH sheathed multicore and LSZH insulated single core cables), unless specified otherwise in the relevant 'system' section of this specification or on the drawings.

Ensure all cables are of the same manufacture and delivered to site in continuous lengths, complete with end caps.

At the manufacturer's works, subject cables to the routine tests detailed in the relevant British Standards. Submit duplicate copies of test certificates to the Contract Administrator.

920 Jointing and terminations

Use cable accessories (terminations and joints) complying with, or that have been tested in accordance with BS EN 61442. Select accessories that are compatible with the cables with which they are used.

Make connections and terminations using lugs and connectors designed for HV applications, and correctly sized for the type and size of conductor. Ensure that all connections and terminations include a moisture block, and for terminations ensure compatibility with the equipment terminals. Connections and terminations may use either compression tooling or be of the shear-bolt type. For compression connectors use a compression tool that does not release until the correct compression has been achieved, and ensure compatibility between the tool, die and connector.

At joints, use solder-less earthing connections comprising a constant-force spring and earthing connection to bond conductor screens. Also use solder-less connection arrangements for the overall screen and armour connections. Ensure that the conductivity and fault current capability of the earth connection across the joint is at least equal to that of the cable without the joint.

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At terminations, ensure that all screens and armour is earthed at both ends of the cable unless specifically detailed otherwise in the relevant 'system' section of this specification or on the drawings. Use glands that are compatible with the cable and the type of termination selected.

The use of cold-shrink, cold-applied or heat-shrink technology for stress control and insulation at terminations is acceptable. Prior to selecting heat-shrink technology, demonstrate that the installation practices to be adopted make the potential risks associated with hazards negligible (eg applied heat, fire hazards, escaping flammable gas and exposure to fumes).

Install overall protection for the cable joint by means of an outer case filled with resin compound or equivalent additional mechanical protection. Where joints are directly buried, ensure that the joint is supported by means of paving flags laid immediately below the bedding sand on which the finished joint rests. Extend the paving flags for a distance of 700 mm beyond each end of the joint. Where joints are installed in locations other than buried, for example in buildings, cable ducts or other similar instances, support the cable joint by means of a cable tray or ladder rack.

Make HV cable terminations at equipment cable boxes. Include a terminal boot to insulate the equipment terminal cable lug connection. Use non-ferrous gland plates for single-core cables. Make the termination straight, without a cross or significant roll of the cores in the cable box, and achieve this requirement using one of the following methods:

- ~ make the final connection to equipment using three single-core cables at each end of the circuit, and install a trifurcating joint within 10 m of the final termination at each end to make a transition to the three-core cable **PREFERRED SOLUTION**
- ~ install any circuit of less than 50 m in length in single-core cables **PREFERRED SOLUTION**
- ~ make the final connection to equipment at one end using a three-core termination made straight and, at the other end of the circuit, using three single-core cables with a trifurcating joint installed within 10 m of the final termination, to make a transition to the three-core cable
- ~ make the final connection to equipment at both ends of the circuit using a three-core termination made straight, and install a cross joint within the circuit route to restore correct phasing
- ~ make the final connection to equipment at one end using a three-core termination made straight and, at the other end of the circuit, at a cast resin transformer, power factor correction cubicle or similar equipment that does not include a cable box and where the space for cable termination is unrestricted, make the final connection using a cross joint to restore correct phasing

When terminating cables at equipment with cable boxes designed for compound filling, ensure that the finished clearances in the box are sufficient for the installed cable and termination type. Acceptable works to ensure compatibility are extending the box by lowering the gland plate or replacing the cable box with a newly fabricated steel box. Do not reuse cast iron cable boxes; replace them with fabricated steel boxes.

Other than at terminations as detailed above, join cables only when they cannot be supplied or installed as a continuous single length. Obtain the written acceptance of the Contract Administrator if cables have to be joined inside buildings.

Use only suitably qualified and experienced persons for the jointing and termination of HV cables who have received a course of instruction on the proposed cable joint and in the use of the specialist tools recommended by the cable joint manufacturer. Ensure that a copy of the training certificate is included in the operating and maintenance instruction manuals and the joints and terminations are traceable to the individual concerned.

Ensure the environmental conditions when jointing or terminating cables are such that the work can be carried out without detriment to the completed joint. Once the cable seal has been broken, ensure that

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the jointing work on the cable end is undertaken continuously until completed and the cable sealed against the ingress of moisture.

930 Installation

Where cables are buried underground, comply with clause Y61.1000 of this specification.

Do not install cables when the temperature is below the higher of:

- ~ the minimum installation and handling temperature specified in the installation recommendations appendix of the appropriate cable standard, or
- ~ the minimum installation and handling temperature given by the cable manufacturer

If the cables have been exposed to such temperature, allow a warming up time before the cables are handled.

Do not bend cables to a radius smaller than the larger of:

- ~ the minimum installation radius specified in the installation recommendations appendix of the appropriate cable standard
- ~ the minimum installation radius given by the cable manufacturer

Arrange single-core cables neatly in close trefoil fixed with cable cleats and intermediate restraints complying with clause Y61.230 of this specification. Fix at intervals compliant with the cleating system certification. When approaching terminations, ensure the cores remain in close trefoil for as long as possible, keeping the splayed length to the minimum that practical considerations will permit, having regard to minimum bending radii.

Arrange cable routes so that cables, hangers, cleats, and the like, do not come into contact with, or in close proximity to, piped services. Ensure a separation of not less than 600 mm from other building engineering services.

Where HV cables are routed within buildings or externally and not underground, install them on continuous ladder rack, heavy duty cable tray or in accessible service ducts. Fix the cables at intervals, in accordance with the manufacturer's recommendations using cleats complying with clause Y61.230 of this specification. Secure each cleat to the ladder rack, cable tray or service duct using bolts. Ensure that the cleat and fixing selection takes into account the full details of the installation including the static load of the cable and any load imposed by, but not limited to, wind, icing and the load for wind including icing. Install suitable supporting steelwork and/ or galvanized cable tray where cables cross open spaces. Protect such steelwork by a rust-inhibiting paint.

Where cables need to be pulled by winches or similar mechanical aids, use such aids fully in accordance with the cable manufacturer's instructions. Record the pulling tension and do not exceed the allowable maximum for the method by which the winch is attached to the cable.

Where cables pass through walls and floors fit them with oversized sleeves permanently fixed, packed with fire resisting infill. Where cables rise or fall on walls, ensure they are protected to a height of 2 m with a sheet steel guard where prone to mechanical damage.

Ensure all cables are installed, straightened and dressed to give a neat and workmanlike installation. Ensure that there is no damage to the cable sheath or outer covering. In the event of any cable being damaged, remove and replace the whole length of cable. Damage includes any instance of bending to a radius less than the normal-use minimum bending radius given in BS EN 50565 or specified by the cable manufacturer.

Perform tests after installation of cables in accordance with the requirements of the installation appendix of the particular Standard to which the cable was manufactured.

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1000 INSTALLATION OF CABLES UNDERGROUND

1010 General

Install only MICC and armoured cable types (HV and LV) underground.

For each respective cable type, comply with the general requirements (including but not limited to installation temperatures, pulling tension, bending radius, etc) specified in the relevant clauses of this section of the specification.

Install underground cables in accordance with the National Joint Utilities Group (NJUG) publication 'Guidelines on the positioning and colour coding of utilities' apparatus'.

Where appropriate install underground cables in accordance with chapter 13 (Gardens) or chapter 5 (Agricultural and horticultural premises) of Guidance Note 7 'Special Locations' published by the IET.

Ensure cables installed direct in ground have a minimum spacing of:

- ~ 300 mm from HV/ EHV cables
- ~ 600 mm from communication cables, alarm cables and gas services
- ~ 800 mm from heating services

Where single-core cables are laid direct in the ground to form a three-phase circuit, lay them in touching trefoil unless specifically detailed otherwise in the relevant 'system' section of this specification or on the drawings. Bind the trefoil group together using heavy-duty cable ties at intervals of one metre, and install the neutral conductor adjacent to the group. Do not energise cables until the cables are buried, as the support in the event of a fault condition is by means of the surrounding ground. Where single-core cables are installed with more than one cable per phase, install the cables in three-phase groups with the neutral conductor alongside each group as described above. If the cables are to be energised prior to being buried use cleats and intermediate restraints as detailed in clause Y61.230 of this specification, to secure the cables.

1020 Burial depths

Bury LV cables to a minimum depth of:

- ~ 600 mm to the top of the cable in unmade ground
- ~ 800 mm in made-up ground, ie roadways, and the like

For HV cables increase these depths respectively to 800 mm and 1000 mm.

Where it is not possible to comply with the depths specified above, install additional protection for the cable so that the overall protection is equivalent to being buried at the normal depth specified. For additional protection, install overlapping stainless steel plates of 8 mm minimum thickness permanently marked to indicate cables are buried below the plate.

1030 Bedding, backfill and marker tape/tiles

Rest cables on a 100 mm deep bed of sifted sand and riddled earth, then cover with a further depth of 100 mm of the same material. Ensure that the selected sand and backfill material are such that the design thermal resistivity of the ground in which the cable is buried does not exceed 1.2 K.m/W (ie the thermal resistivity upon which the cable rating is based).

Use only excavated material for backfill in areas that will remain unmade ground, for example grass verges; in other areas use crushed stone fill that will ensure the bearing capacity of the final surface is achieved.

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Install two layers of marker tape along the entire length of each cable. Place the lower layer 50 mm above the cable and the higher layer 300 mm above. Use durable heavy-duty (0.1 mm thick) yellow-coloured marker tape, 150 mm wide, manufactured from recycled polyethylene polymers, and marked "ELECTRIC CABLE BELOW – CAUTION" in permanent black lettering printed continuously along its length. For HV cables, substitute the lower layer of tape with cable tiles. Use durable heavy-duty (minimum 12 mm thick) cables tiles, manufactured from high-impact recycled polyethylene sheet, and having the words "HV ELECTRICAL CABLE BELOW – CAUTION" cast in them.

Ensure that backfill does not contain stone, brick, or any sharp material and is fully consolidated by means of a rammer to the 300 mm level before the second tape is laid. Only then carry out the final backfill to ground level and suitably consolidate.

1040 Cable conduits

Protect cables passing under roadways and at all other areas of vehicular traffic, using circular conduits encased in concrete.

Ensure cable conduits for cables underground are circular non-metallic and comply with BS EN 61386-24. Use conduit system type 450 or 750, resistance to impact 'normal'. Do not use conduits smaller than nominal size 50 mm (37 mm internal diameter.) Select a non-threaded entry system (socket and spigot type). For conduits installed straight between points select a rigid system; for conduits that require deviation from a straight route, select pliable conduits.

For cables installed in conduits seal around the cables at all ends of conduits (including where they enter a building), by a waterproof and gas-proof seal of self-extinguishing plastic foam of a type approved by the Energy Networks Association. Fit suitable end caps to all unused spare conduits.

1050 Cable route markers

Install cable route markers where cables are laid in grass verges, paved areas and the like. Space the cable route markers at 45 m intervals on straight routes. Also place markers over all tee-joints, at changes of direction, where cables cross roads, and at building entries. Ensure that all markers are of a proprietary type, 200 mm square 50 mm deep, concrete with plastic inserts indicating the depth and voltage of the cable(s), and are laid level with the finished surface.

1060 Location plans

Produce accurate plans with dimensions and GPS coordinates so that the location of any cable can be determined with a maximum uncertainty of 100 mm from local fixed features. Where multiple cables follow a route, record the relative positions of the cables and indicate the locations of any cables that cross, and the relationship with key features of any other buried service. Accurately record the location of cable joints using GPS coordinates.

1100 MODULAR WIRING

Use a modular wiring system that complies with BS 8488.

Forward fully dimensioned manufacturing and installation drawings of the entire modular wiring system to the Contract Administrator for comment prior to installation.

Unless indicated otherwise by the relevant 'system' section of this specification or the drawings, provide 5% as spares for all connectors and provide ordering details for replacement parts.

Ensure that the system components provide separated systems for lighting, power, clean earth power, IT earthing systems, data and communications, bus systems and other ELV controls. Ensure that connections/connectors for these types of components cannot be interchanged.

Ensure that the distribution units are secured to surfaces in concealed locations (eg to cable tray where in a void beneath a raised access floor or, where in a ceiling void, to the soffit of the floor or roof above).

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Ensure that the interconnecting cables are of a type producing low levels of smoke and zero halogens (LSZH sheathed multicore and LSZH insulated single core cables) when affected by fire, and are compliant with BS EN 50525-3-41.

Ensure that all containment of the modular wiring system is of a type producing low levels of smoke and zero halogens such that a coordinated strategy for LSZH materials in the cabling and containment systems is achieved.

Ensure that the system incorporates installation couplers complying with BS EN 61535.

Ensure that all interconnecting cables are mechanically protected by flexible metallic conduits and suitable for the environment in which they are installed. Ensure that plug-in connections are mechanically and electrically secure and that they cannot be inadvertently dislodged. Make sure that all connections are shrouded and are of the male/female type to ensure that no live parts can be exposed to touch when a component is unplugged. Ensure that the components containing the interconnecting cables are selected, manufactured and installed so that they are routed orthogonally, ie at right angles.

Ensure that the cables and connectors are sized to have current ratings not less than the circuit protective device at the origin with any grouping de-rating factor applied. When calculating cable sizes, ensure that the orthogonal routing of conductors is accounted for in the design cable lengths.

Ensure where the wiring system comprises a number of circuits connected to separate overcurrent protection that they emanate from LV switchgear and control gear assembly, which conforms to the relevant part of BS EN 61439 or BS EN 61534.

Where the LV switchgear and control gear assembly contains the wiring system overcurrent protection, ensure that connector to the LV switchgear and control gear assembly conforms to BS EN 61984 and the installation coupler to the LV switchgear and control gear assembly conforms to BS EN 61535.

Ensure earth continuity and continuity of the circuit protective conductor throughout, which may be specified as a dedicated clean electrical earth.

Ensure that the flexible conduit wiring sections are routed orthogonally (ie at right angles to each other) and are secured to the sub-floor slab or soffit.

Ensure that each individual section of the installation is distinctly and durably marked with the following information:

- ~ the origin (trade mark / manufacturers identification mark / name of responsible vendor)
- ~ rated current and reference installation method from BS 7671 Table 4A2
- ~ rated voltage
- ~ IP code if higher than IP20
- ~ manufacturers model number or type reference
- ~ unique manufacturing batch reference for traceability
- ~ electrical test status in line with BS 8488

Ensure that the complete assembled system is designed, installed, tested and commissioned to BS 7671, and ensure that the specialist manufacturer / supplier provides all relevant system design information validating conformity with BS 7671.

END OF SECTION Y61

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Y62 BUSBAR TRUNKING

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Y62 BUSBAR TRUNKING

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly, for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

The Electrical Equipment (Safety) Regulations

The Electromagnetic Compatibility Regulations

BS 159	Specification for high voltage busbar and busbar connections
BS 476	Fire tests on building materials and structures
BS 6423	Code of practice for maintenance of electrical switchgear and controlgear for voltages up to and including 1 kV
BS 6946	Specification for metal channel cable support systems for electrical installations
BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 8602	Method for the assessment of fire integrity of cast resin busbar trunking systems for the safety critical power distribution to life safety and fire fighting systems
BS EN 1366-3	Fire resistance tests for service installations
BS EN 13599	Copper and copper alloys. Copper plate, sheet and strip for electrical purposes
BS EN 13600	Copper and copper alloys. Seamless copper tubes for electrical purposes
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
BS EN 13602	Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors
BS EN 60269-1	Low-voltage fuses. General requirements
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)
BS EN 60898-1	Electrical accessories. Circuit breakers for overcurrent protection for household and similar installations. Circuit breakers for ac operation
BS EN 60947-1	Low-voltage switchgear and controlgear Part 1: General rules
BS EN 60947-3	Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN 61009-1	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs). General rules
BS EN 61439-6	Low-voltage switchgear and controlgear assemblies Part 6: Busbar trunking systems (busways)

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Y62 BUSBAR TRUNKING

BS EN 61534	Powertrack systems. General requirements
BS EN 62208	Empty enclosures for low-voltage switchgear and controlgear assemblies. General requirements
BS EN ISO 1461	Hot dipped galvanized coatings on fabricated iron and steel articles. Specifications and test methods

200 GENERAL – BUSBAR SYSTEMS

Provide for all busbar components and units ensuring full compatibility between them. Allow for all busbar trunking feeder units, tap off units, adapter units, thermal expansion units, flexible units and all other units or components as indicated by the drawings and/or specification.

Ensure the busbar trunking is designed for horizontal installation, rising mains or for feeder application as indicated by the drawings and/or specification.

Ensure the current rating of the installed busbar trunking is as indicated by the drawings and/or specification after application of any manufacturers derating factors applicable to installation.

Ensure the equipment is suitable for the voltage, frequency, number of phases, including any neutral and earthing requirements as indicated by the drawings and/or specification.

Ensure the busbar trunking system is designed and manufactured to comply with BS EN 61439-6.

Ensure the powertrack system is designed and manufactured to comply with BS EN 61534.

Install busbar trunking and powertrack systems in accordance with manufacturer's instructions taking account of external influences.

Ensure that the conductor bars are arranged in a sandwich (compact) configuration such that the distance between them is less than the thickness of each phase conductor. Ensure that sandwich configuration busbars are individually insulated and mounted to form a sandwich of conductors and insulation with the busbar casing.

Ensure that phase and neutral bars are of the same cross section. Reduced neutral bars will only be acceptable if instructed by the Contract Administrator. Do not use phase reducers.

Ensure that conductor joints consist of pre-tapped fishplates suitable for bolts to be tightened to the torque recommended by the manufacturer.

Ensure that all conductor joints are enclosed in sheet steel cover(s) to prevent unauthorised adjustment of the torqued bolts.

Provide manufacturer's purpose-made fittings, including all panel flanges, bends, flexibles, tee pieces, offsets and special lengths etc, where a change of direction or termination occurs in a busbar run.

Ensure that all sheet metal cut ends are de-burred and painted prior to assembly.

Ensure that where the busbar trunking penetrates elements of fire rated building construction it is sealed internally and externally to the same degree of fire resistance as the penetrated element.

Provide crossing plates on both sides of the aperture to ensure a tidy finish, when the busbar trunking passes through a floor or wall.

Provide tapping positions along the length of the trunking as indicated by the drawings and/or specification.

Ensure the trunking is suitable for normal mechanical loads, unless otherwise specified, and that it will not be used to support other equipment.

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Y62 BUSBAR TRUNKING

Ensure the phase sequence is maintained along the length of the busbar trunking system and is identical to all systems in the installation. Busbar phase colour to be clearly marked in each trunking unit.

300 BUSBAR TRUNKING SYSTEMS

Ensure that the busbar trunking is capable of withstanding the prospective fault current indicated by the drawings and/or specification. Ensure the busbar trunking is dimensioned to fit the allocated space. Provision for closing sections, manufactured by the original manufacturer to the same standard as the main section, after final site measurements, must be agreed with the Contract Administrator. Ensure the busbar trunking is provided with self-aligning mechanical and electrical joint sleeve(s) for busbar section jointing, or pre-fabricated interlocking joints.

Provide end cap(s) manufactured from non-hygroscopic, self-extinguishing, halogen-free material.

Ensure flanges are available on the trunking to accept the manufacturer's suspension flanges.

Provide factory-fitted thrust block(s) for rising main applications.

Ensure that the busbar trunking is fitted with proprietary fittings, to allow for thermal expansion in the busbar and movement across building expansion joints.

Where required, provide a vibration absorber connection bar to enable flexible connection between busbar and power equipment, eg transformers.

400 TAP-OFF UNITS

Ensure that tap-off units have current ratings as indicated by the drawings and/or specification.

Ensure that tap-off units and feeder units fitted with protective devices conform to the verification requirements of BS EN 61439-6.

Ensure that tap-off units are either the plug-in type or bolt-on type to suit the type of busbar trunking, as indicated by the drawings and/or specification.

Ensure that tap-off units are pre-wired.

Ensure that tap-off units can be removed without the need to de-energise the busbar, if it is a plug-in type.

Ensure that tap-off units are manufactured so that current carrying metal is not exposed during insertion.

Provide safety device on tap-off units to ensure non-reversibility of the pins, when it is connected to the busbar.

Provide self-sealing auto shutters or tap-off blanking plates for all tap-off outlets not fitted with tap-off units.

Provide mechanical tap-off interlocking devices(s) to enable segregation of different types of systems, eg voltage, frequency etc, supported by the same busbar enclosure.

Provide attachments to tap-off units, eg transmitters and receivers for control purposes as indicated by the drawings and/or specification.

500 BUSBAR FEED UNIT

Ensure the feed unit current rating is as indicated by the drawings and/or specification.

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Y62 BUSBAR TRUNKING

Ensure the feed unit is a sealed box with cable termination.

Ensure the feed unit is manufactured from self-extinguishing material.

Fit the feed unit with an isolating switch, unless otherwise specified.

Provide the unit(s) with terminals sized to accommodate the incoming cabling indicated by the drawings and/or specification.

600 SUPPORT SYSTEM

Install the busbar either flat or on edge as indicated by the drawings and/or specification, and in accordance with the manufacturer's instructions.

Provide manufacturer's fixing brackets/supports to suit the trunking profile, unless otherwise specified. Fix the brackets/supports at the manufacturer's recommended spacing intervals.

Ensure that adequate secondary supports are provided to ensure a safe installation.

700 BUSBAR EARTHING

Provide a complete earthing system for the busbar trunking system to comply with the requirements of BS 7430.

Ensure the earthing system associated with the busbar is capable of carrying not only the prospective earth fault current but also current due to earth leakage (protective conductor current) from equipment connected. Ensure the earthing conductor is compliant with the requirements of a high-integrity earthing conductor as required within BS 7671, where equipment with earth leakage is likely.

800 STORAGE AND INSTALLATION

Protect all busbar trunking system and powertrack system components prior to installation from contamination or damage due to dust, condensation or other external influences. Maintain such protection until the busbar trunking system achieves the IP rating specified and site work has been completed.

Protect floor mounted powertrack systems from damage after installation and prior to false floor installation. Ensure that the installed false floor affords continued protection to the powertrack system.

Check all components for mechanical damage and insulation resistance immediately prior to installation. Check and verify that all tap-offs, end-feeds and centre-feeds are seated, engaged and fixed correctly and safely in accordance with the manufacturer's instructions.

Install all components in accordance with manufacturer's recommendations and BS 7671.

900 TESTING AND COMMISSIONING

Comply with specification section Y81.

For all busbar trunking systems, provide the manufacturer's ASTA and type test certification.

Insulation resistance test the installation and provide the results to the Contract Administrator.

Test all the busbar joints and connections to ensure that the system is continuous with test readings within the tolerances set by manufacturer. Rectify and retest all joints and connections that exceed

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tolerances set by the manufacturer. Ensure that all joints and connections after rectification are within tolerances set by the manufacturer.

Undertake thermal imaging of all busbar trunking connections and terminations under site loading and include the results in the operating and maintenance instruction manuals.

END OF SECTION Y62

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Y63 SUPPORT COMPONENTS CABLES

Y63 SUPPORT COMPONENTS CABLES

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

BS 476-6	Fire tests on building materials and structures. Method of test for fire propagation for products
BS 476-7	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products
BS 1449-1.1	Steel plate, sheet and strip. Carbon and carbon-manganese plate, sheet and strip. General specification
BS 6946	Specification for metal channel cable support systems for electrical installations
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 8313	Code of practice for accommodation of building services in ducts
BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications. Code of practice
BS EN 10088-3	Stainless steels. Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
BS EN 10143	Continuously hot-dip coated steel sheet and strip. Tolerances on dimensions and shape
BS EN 10244-1	Steel wire and wire products. Non-ferrous metallic coatings on steel wire. General principles
BS EN 10244-2	Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings
BS EN 10346	Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions
BS EN 50174-2	Information technology. Cabling installation. Installation planning and practices inside buildings
BS EN 61914	Cable cleats for electrical installations
BS EN 61537	Cable management. Cable tray systems and cable ladder systems
BS EN 62275	Cable management systems. Cable ties for electrical installations
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
BS EN ISO 2081	Metallic and other inorganic coatings. Electroplated coatings of zinc with supplementary treatments on iron or steel

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BS EN ISO 14713-1	Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel in structures. General principles of design and corrosion resistance
BS EN ISO 17668	Zinc diffusion coatings on ferrous products. Sherardizing. Specification
BS EN ISO 12683	Mechanically deposited coatings of zinc. Specification and test methods

200 GENERAL REQUIREMENTS

210 General

This specification applies to cable tray systems, wire tray, cable ladder systems and cable matting systems for cable management. The specification is also applicable for metal channel cable support systems for electrical installations where they are used as support devices for cable tray systems, cable ladder systems or independently for cable management. Note the term 'manufacturer' used in this specification includes the term responsible vendor as used in BS EN 61537.

Obtain all cable system components and fixings from a single manufacturer.

Size and select the containment system to be fit for purpose, to include a spare capacity of 30% and to withstand the effects of cable weight and the forces during a cable fault. Where appropriate, make further allowance in the selection of the containment system to take account of other loads such as those due to wind, snow and ice.

Allow 30% of the base area of the cable containment length and of the safe working load (SWL) as spare capacity for future cables when sizing and placing support components. Make allowance within the support components and system selection, where appropriate, for the additional load that could be placed upon the system due to wind, snow, ice, etc.

Ensure that all ferrous metal for cable tray, cable ladder, and wire cable tray lengths, their fixings and suspension components have a resistance against corrosion classification to BS EN 61537 as follows:

- ~ Class 2 minimum for all indoor heated spaces
- ~ Class 3 or Class 4 for all indoor heated spaces containing mission critical IT (eg datacentres)
- ~ Class 5 minimum for all external areas, plant rooms and risers
- ~ Class 5 minimum for all indoor unheated spaces subject to high moisture levels and/or condensation

Use metal channel support systems that comply with BS 6946 or support devices that are part of the cable tray system or cable ladder system to support cable runway.

Ensure that all surfaces, which are likely to come into contact with cables during installation or use, do not cause damage to the cables.

Ensure that all surfaces are safe for handling and that sharp edges and burrs are removed.

Do not place dissimilar metals liable to initiate electrolytic action, or other materials liable to cause mutual or individual deterioration, in contact with each other unless specific arrangements are made to avoid the consequences of such contact.

Never allow any copper cable or fitting to be in contact with the galvanising. Generally ensure that cables have an outer covering of polymeric material that prevents contact between the metal parts of the cable and the supports. Where cables have no outer covering then lay them on a layer of polymeric material securely fixed to the support components. Ensure that any additional polymeric material does not add to the spread of fire, smoke or the generation of corrosive gases in the event of a fire.

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Use standard fittings that are supplied as part of the cable tray system or cable ladder systems; if local situations make it impracticable, fabricated fittings are acceptable provided they are of the same quality and the same protective finish as the standard fittings.

Ensure that sets and bends are sized to allow for the minimum permissible radius of the largest cable and that cables retain their relative positions on all bends and sweeps.

Fit grommets to all holes cut into the support components.

Maintain electrical continuity at all joints with suitable earthing links. Ensure that joints have all burrs removed and are made by fishplates and screws.

Ensure that the weight of cables is uniformly distributed on the cable tray system or cable ladder system with the exception of cable management systems supported via cantilevered support arrangement. Where cantilever supports are provided, align the heavier cabling closest to the vertical support surface. Ensure that the weight imposed onto the cable support system does not exceed the SWL specified by the manufacturer (including future allowance).

Where cables of fire resisting construction are carried on the containment system, provide a cable support system achieving a level of fire resistance as calculable according to Annex E of BS 8519.

Ensure that mitigation of building expansion is incorporated in the installation of the cable support components.

220 Installation

Provide all fixings in compliance with Y90.

Provide all suspension systems used for support in compliance with Y93.

Comply with the written installation instructions of the cable tray, cable ladder or wire cable tray system manufacturer.

Use butt joints to connect adjacent cable tray or ladder lengths or to connect to fittings. Do not weld any joints. Ensure that every connection is mechanically strong, allowing no relative movement between the two components.

Install the cable runway on mild steel support devices having suitable protective coating, fixed to the structure at not more than 1 metre intervals, or at such spacing as to ensure the SWL of the system is not exceeded. For sides, bends and intersections provide supports at a distance not exceeding 300 mm. Use external fixing devices of expanding masonry bolts or equal. Alternatively, use proprietary steel channel permitting easy adjustment and modification. Proprietary clamp fixings onto the flanges of structural beams are also permitted.

Allow 75mm minimum space between any part of the cable tray or cable ladder system and structure to give ease for securing the cable fixings and general maintenance. Comply with the minimum spacing between services as set out in BS 8313.

Avoid any obstruction and all other services to ensure that the installation can be properly installed and maintained.

Check and agree with the engineer and architect the final positioning and routing of all exposed containment systems. Provide detailed and dimensioned coordinated construction drawings for this purpose.

Provide and install proprietary plastic caps to the ends of threaded rod. Cap the ends of channel support systems using proprietary caps.

Ensure that internal fixing devices and external fixing devices do not come into contact with cables in a way that may give rise to damage of the cables.

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Prime and paint all metalwork, exposed cut ends, fixing bolts, mild steel supports, brackets, etc., where the manufacturer's galvanised coating is damaged, or where no galvanised coating has been applied, with two coats of zinc-enriched paint.

230 Safety

Do not use any part of the cable support installation at any time as part of a fall arrest system.

Ensure that the cable support installation is coordinated with any spatial requirements necessary to accommodate all installation and future access requirements.

300 PRODUCTS AND MATERIALS

310 Cable tray systems

311 General

Ensure that cable tray lengths and fittings that form the cable runway comply with BS EN 61537 are of perforated sheet steel meeting classification D in accordance with BS EN 61537 and are formed with a return flange. Ensure steel complies with BS 1449-1.

Ensure that cable tray systems have electrical continuity characteristics in accordance with BS EN 61537, can fulfil a protective earth (PE) function, and are bonded and earthed throughout. Fix copper connectors with tinned connections across all joints of the cable trays in order to maintain the earth continuity. Ensure that the length of the copper connector is slightly longer than the distance of its attachment points to allow for movement or expansion of the joint.

As a minimum use medium-duty trays internally, heavy-duty trays for external work, or as appropriate to the installation conditions and manufacturers guidance.

Use a dropout plate of the same width as the cable tray or other proprietary cable guide product as the cables exit the cable tray.

Select the size and type of cable tray bends according to the most onerous bending radii requirements.

312 Installation

Cut cable trays along a line of plain metal only; do not cut through the perforations. Remove all burrs from cut edges so that surfaces are smooth and clean before painting. Treat all cut edges with a zinc enriched paint.

Achieve the jointing of cable tray lengths and the fixing of the cable runway tray to support devices, by means of sherardized steel mushroom headed bolts and nuts with the threaded portion away from the cables.

Where cable tray systems are installed across building expansion joints fit a proprietary slip connector fixed at one end only.

320 Cable ladder systems

321 General

Ensure that cable ladder lengths and fittings that form the cable runway, comply with BS EN 61537 meeting classification Z in accordance with BS EN 61537. Ensure steel complies with BS 1449-1. Select a type that has slotted side sections and rungs, and has side sections that are profiled for rigidity.

Ensure that cable ladder systems have electrical continuity characteristics in accordance with BS EN 61537, can fulfil a PE function, and are bonded and earthed throughout. Fix copper connectors with tinned connections across all joints of the cable ladder in order to maintain the earth continuity. Ensure

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that the length of the copper connector is slightly longer than the distance of its attachment points to allow for movement or expansion of the joint.

As a minimum use medium-duty cable ladder internally, heavy-duty or extra-heavy-duty cable ladder for external work, or as appropriate to the installation conditions and manufacturers guidance.

Use a dropout plate of the same width as the cable ladder to support the cables as they exit the ladder.

Ensure that the inside radius of all bends in the cable runway is greater than 300mm and large enough to accommodate the minimum bending radius allowed for any cable installed on the ladder.

322 Installation

Use flexible couplers to joint cable ladder systems across expansion joints of the building structure. Do not use rigid fittings across expansion joints.

Treat all cut edges with a zinc enriched paint.

Fit ladder covers, where specified, in accordance with the manufacturer's instructions.

330 Wire cable tray systems

331 General

Ensure that wire cable tray (cable basket) lengths and fittings that form the cable runway comply with BS EN 61537, are made of high strength steel wires formed into wire mesh pattern with intersecting wires welded together. Use wire cable tray lengths and fittings from lateral and longitudinal sidewall steel wires with minimum diameters of: 4mm for wire cable tray widths up to 100mm, 5mm for wire cable tray widths of 150mm and 200mm, and 6mm for wire cable tray widths of 300mm or greater.

Ensure that wire cable tray systems have electrical continuity characteristics in accordance with BS EN 61537, can fulfil a PE function, and are bonded and earthed throughout. Fix copper connectors with tinned connections across all joints of wire cable trays to maintain earth continuity. Ensure that the length of each such copper connector is slightly longer than the distance of its attachment points, to allow for movement or expansion of the joint.

Use a dropout plate of the same width as the wire cable tray or other proprietary cable guide product where more than two cables exit the tray, in all other cases provide suitable cable support to prevent physical stress on the cable(s). Where cables exit the wire cable tray within conduit, provide a proprietary conduit take off bracket to secure the conduit to the tray.

Check that all wire ends along the basket's sides are rounded during manufacturing, to ensure the safety of cables and installers.

Use only centre support hangers, trapeze hangers or wall brackets, to support the wire cable tray system.

332 Installation

Use side action bolt cutters with offset jaws to cut mesh wires; do not use saws, nor cutters with centre cut jaws. Make cuts at the intersection of longitudinal and lateral wires. Treat all cut edges with a zinc enriched paint.

Use serrated flange locknuts and bolts for all splicing assemblies.

Use flexible couplers to joint cable basket systems across expansion joints of the building structure. Do not use rigid fittings across expansion joints.

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340 Cable matting

Use cable matting manufactured from flexible, elastomeric, moisture resistant, closed cell, foam rubber.

Ensure that the cable matting system complies with BS 476 parts 6 and 7, is resistant to flame spread and is certified to be of fire rating class 1.

Ensure that all parts of the cable matting system are constructed from low smoke and zero halogen (LSZH) material.

Where matting is applied directly to the sub floor in areas with an accessible floor system, provide matting of minimum 13mm thickness. Where applied to cable tray, apply matting of minimum thickness of 6mm.

Cut the cable matting using a proprietary tool as recommended by the manufacturer and join lengths of cable matting using a proprietary tape that maintains the fire resistant properties of the mat.

Where required to traverse obstructions, apply the cable matting to proprietary bridging pieces constructed of LSZH material.

350 Cable cleats

Use cable cleats that are made from materials that are resistant to corrosion without the need for any treatment. Ensure that plastic materials are non-brittle down to -20°C. For cables having low emission of smoke and zero halogens (LSZH) when exposed to high levels of heat, use non-metallic or aluminium cleats made from LSZH material. Use trefoil cleats for single core cables.

Ensure that cleats are of such a size that they can be tightened down to grip the cables without exerting undue pressure or strain and allows for longitudinal expansion of the cable. For vertical cables, use two-bolt cleats which grip the cables firmly enough to prevent them from slipping.

Space cable cleats in accordance with the minimum spacings in accordance with the manufacturer's recommendations. Locate cleats immediately before and after any bends in the cable. Ensure that cleats and other cable support systems are adequately supported themselves by fixing into a suitable substrate, and that the fixing to the substrate will maintain its integrity in fire conditions to an equal degree of performance as the cable support system.

360 Cable installation

Provide cable cleats and cable ties to BS EN 61914 and BS EN 62275 respectively. Use only proprietary cable support systems and fixings.

Support wiring systems such that they will not prematurely collapse in the event of a fire, use only metal cable fixings.

Where final-circuit or other minor-gauge cabling is laid in and is supported by incombustible support components, secure them with zero halogen, self-extinguishing, ultra-violet resistant ties. For all other cabling, use plastic coated metallic cable ties or metallic cable cleats. Do not use wire or similar material for cable ties.

Install cables individually and lay the cables in or on support components.

Where single core conductors are arranged in three phase parallel configuration, ensure equal current sharing between the parallel conductors via a suitable arrangement of the conductors, ensure that conductors of the same phase are not grouped together. Where parallels of no more than two conductors per phase are to be installed, install these on ladder rack and according to the following arrangements:

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- ~ Three phase (no neutral), arranged as trefoil sub-groups spaced from one another by twice the cable diameter.
- ~ Three phase and neutral, arranged as quadrofoil sub-groups, with L3 and L2 arranged adjacent to L1 with the neutral conductor opposite L1, with each group spaced from one another by twice the cable diameter.

Where parallel single core conductors are installed, verify that the load current is shared evenly at varying load conditions and phase imbalance.

Ensure that cables are protected from damage during installation. Replace all damaged cable immediately on discovery.

Fix cables to support components at minimum spacing in accordance with the manufacturer's recommendations. Do not allow any cable to be used to support the weight of any item other than its own self weight.

Where the final circuit cable installation is intended to be installed without containment as in clipped direct installations using multicore cabling, fix these cables to maximise their capacity by installing multiple bunches of no more than ten cables in any one bunch with heavy loads separated.

Where cables are fitted to support components that are:

- ~ mounted in the horizontal plane running horizontally but with cables fitted to the underside, or
- ~ mounted in the vertical plane running horizontally, or
- ~ mounted in the vertical plane running vertically

Secure cables using plastic coated metal straps or proprietary cleats of a pattern recommended by the cable manufacturer.

Secure HV cables in accordance with the requirements of section Y61 of this specification.

Ensure that all fixing bolts/studs are sherardized and where necessary of sufficient length to allow stacking of cables.

END OF SECTION Y63

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a Standard referred to in this section conflicts with a Standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the Standard referred to in the engineering system section prevails.

BS 88	Low-voltage fuses
BS 89	Direct acting indicating analogue electrical measuring instruments and their accessories
BS 90	Specification for direct-acting electrical recording instruments and their accessories
BS 159	Specification for high-voltage busbars and busbar connections
BS 842	Specification for a.c. voltage-operated earth-leakage circuit breakers
BS 3036	Specification. Semi-enclosed electric fuses. (Ratings up to 100 amperes and 240 volts to earth)
BS 4293	Specification for residual current-operated circuit-breakers
BS 5424-2	LV controlgear. Specification for semiconductor contractors (solid state contractors)
BS 5424-3	Specification for controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.
BS 5472	Specification for low voltage switchgear and controlgear for industrial use. Terminal marking and distinctive number. General rules
BS 6231	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring
BS 6272	Specification for low voltage switchgear and controlgear for industrial use. Terminal marking. Terminals for external associated electronic circuit components and contacts
BS 6423	Code of practice for maintenance of electrical switchgear and controlgear for voltages up to and including 1 kV
BS 7194	Specification for direct-current and low-frequency electronic measuring instruments with a digital display
BS 7211	Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire
BS 7264-2	Shut capacitors for a.c. power systems having a rated voltage above 1000 V
BS 7288	Specification for socket outlets incorporating residual current devices (S.R.C.D.s)
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

BS 8431	Electrical static meters for secondary metering and sub-metering. Specification
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
BS EN 13602	Copper and copper alloys. Drawn, round copper wire for the manufacture of electrical conductors
BS EN 60044	Instrument transformers
BS EN 60076-1	Power transformers. General
BS EN 60076-6	Power transformers. Reactors
BS EN 60079	Explosive atmospheres relay
BS EN 60255	Measuring relays and protection equipment
BS EN 60269-1	Low-voltage fuses. General requirements
BS EN 60269-4	Low-voltage fuses. Supplementary requirements for fuse-links for the protection of semiconductor devices
BS EN 60439	Low-voltage switchgear and controlgear assemblies
BS EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals, conductor terminations and conductors
BS EN 60521	Class 0.5, 1 and 2 alternating-current watthour meters
BS EN 60529	Specification for degrees of protection provided by enclosures (IP Code)
BS EN 60831	Shunt capacitors of the self-healing type for a.c. power systems having a rated voltage up to and including 1000 V
BS EN 60898	Specification for circuit-breakers for overcurrent protection for household and similar installations
BS EN 60947-1	Low-voltage switchgear and controlgear. General rules
BS EN 60947-2	Low-voltage switchgear and controlgear. Circuit breakers
BS EN 60947-3	Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN 60947-4-1	Low-voltage switchgear and controlgear. Contactors and motor-starters. Electromagnetic contactors and motor-starters
BS EN 60947-4-3	Low-voltage switchgear and controlgear. Contactors and motor-starters. AC semiconductor controllers and contactors for non-motor loads
BS EN 61008-1	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's). General rules
BS EN 61009	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)
BS EN 61439	Low-voltage switchgear and controlgear assemblies
BS EN 61642	Industrial a.c. networks affected by harmonics. Application of filters and shunt capacitors
BS EN 61869-2	Instrument transformers. Additional requirements for current transformers
BS EN 61921	Power capacitors. Low-voltage power factor correction banks
BS EN 62053-21	Electricity metering equipment (a.c.). Particular requirements. Static meters for active energy (classes 1 and 2)

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BS EN 62053-23 Electricity metering equipment (a.c.). Particular requirements. Static meters for reactive energy (classes 2 and 3)

200 PRODUCTS AND MATERIALS

210 Assemblies

Ensure all LV switchgear and controlgear assemblies have verification by either testing, calculation or design rules, to BS EN 61439. Ensure that the assembly maintains BS EN 61439 verification after integration into the on-site electrical systems.

Ensure all individual devices and self-contained components within assemblies conform to relevant product standards.

Ensure all equipment is free of damage and any deterioration from the manufacturer's intended standard before incorporation into the on-site electrical system.

220 Switchgear

221 Switchgear: 500 V

This clause covers circuit breakers, switches, disconnectors, switch-disconnectors and fuse-combination units and their associated controlgear.

Ensure that all switchgear and controlgear complies with BS EN 60947-1, BS EN 60947-2 and BS EN 60947-3.

Handle and mount all loose switchgear and assemblies in accordance with manufacturer's instructions at locations defined by the drawings or the relevant 'system' sections of this specification.

Ensure that all short circuit ratings, current ratings, number of poles and fusing arrangements are as indicated by the drawings or the relevant 'system' sections of this specification.

Contain the neutral connection/link of each circuit breaker, switch, disconnector, switch-disconnector, and fuse-combination unit within its respective enclosure/moulding.

Ensure that all multi-pole isolators conform to BS EN 60947-3 and are of Utilisation Category AC-23A. Provide high breaking capacity fuses to Class 'gG' to BS EN 60269-1 unless stated otherwise in the relevant 'system' sections of this specification. Ensure that they are of the make and ratings indicated by the drawings or the relevant 'system' sections of this specification. Fit fuse carriers rated at 200 A and over, with wedge or bolted contacts. Provide spare fuses of the number and sizes indicated by the relevant 'system' sections of this specification.

Ensure that all isolators and fuse-switches, are suitable for padlocking in the OFF position. Where isolators and fuse-switches are used for fire alarm, intruder alarm, UPS supplies, etc, ensure that they are also suitable for padlocking in the ON position.

Ensure that each type of switchgear classified as either circuit breakers, switches, disconnectors, switch-disconnectors and fuse-combination units under BS EN 60947 is of the same manufacture as all other switchgear of that type.

Provide sufficient space in all enclosures to accommodate external conductors from point of entry to terminal in accordance with BS EN 60947.

222 Switchgear: 250 V

Ensure that where 250 V rated switchgear (eg a consumer unit) is used it is not within 2.0 m of any other phase within the same room. Where multiple phases are within 2.0 m of each other use 500 V rated switchgear.

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

230 Consumer units

Use consumer units (eg a distribution board intended to be operated by ordinary persons) to BS EN 61439-3 rated for 250 V where no other phase is within 2.0 m, otherwise use a 500 V distribution board.

Ensure that all consumer units are either manufactured from non-combustible material or located within an enclosure constructed of non-combustible material in accordance with IET regulation 421.1.201.

Ensure that outgoing circuit protection is afforded by BS EN 60269 cartridge fuse links appropriate to the circuit rating, unless miniature circuit breaker (MCB) units are indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that all consumer units are complete with a suitably sized integral double-pole isolator.

Ensure that all consumer units are fitted with multi-connection earth and neutral terminal bars to provide a separate connection for each conductor connecting to the terminal bars.

Make neutral and earthing connections to the terminal bars so that the respective circuit neutral and earth cables follow the same pattern and direction as those of the phase conductors.

240 Residual current-operated circuit breakers (RCCBs)

Unless otherwise specified use RCCBs having a sensitivity of 30 mA.

Ensure that all RCCB units without integral overcurrent protection conform fully to BS EN 61008 and are of the sensitivities, load ratings and pole configurations indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that all RCCB units with integral overcurrent protection conform fully to BS EN 61009 and are of the sensitivities, load ratings and pole configurations indicated by the drawings or the relevant 'system' sections of this specification.

Adhere to the selected RCCB manufacturer's installation requirements. Ensure that the respective breaker trips lie within the time limits recommended for the category of breaker.

250 Distribution boards

251 General

Ensure that adequate provision is made within every distribution board to receive the specified cabling and that it is physically sized to suit the proposed installation location.

Ensure within TP&N distribution boards that the earth and neutral terminal bars have sufficient terminations for the maximum number of single phase circuits that the board can accommodate.

Ensure that insulated barriers and phase segregation barriers are properly fitted in every distribution board to prevent accidental contact.

Ensure that all cable entries into every distribution board are made to uphold the ingress protection rating of the associated distribution board and be a minimum of IP31 to BS EN 60529.

Mount distribution boards so that they are readily accessible and fixed firmly to masonry by plated anchors, each having a loose bolt and washer or by other approved fixing, or by nuts, bolts and washers to a painted mild steel framework.

252 HBC distribution boards

Ensure that all distribution boards have a minimum rating of 400 V with the number of ways and fuse ratings as indicated by the drawings or the relevant 'system' sections of this specification. Ensure they conform to BS EN 60947-3 and are of the same finish and manufacture as the main switchgear/panels selected for the works.

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

Supply all distribution boards complete with cartridge type fuses conforming to BS EN 60269-1. Ensure that every distribution board is complete with multi-connection earth and neutral terminal bars having a separate connection for each conductor.

253 Miniature circuit breaker (MCB) distribution boards

Ensure that all MCB distribution boards have a minimum rating of 400 V with the number of ways and MCB of the sizes indicated by the drawings or the relevant 'system' sections of this specification. Ensure they conform to BS EN 60947-3 and are of the same finish and manufacture as the main switchgear/panels selected for the works.

Ensure that every MCB conforms to BS EN 60898-1, Type C (instantaneous trip current range) with 10 kA short-circuit capacity rating unless indicated otherwise by the drawings or the relevant 'system' sections of this specification.

Securely clamp every MCB to its busbars, or properly install the plug-in type.

Use combined MCB/RCCB units where indicated by the drawings.

Ensure that where the selected manufacturer's RCCB unit(s) takes up more than one way on a board, a larger board is provided so as not to compromise the number of spare ways required by the drawings or the relevant 'system' sections of this specification.

260 Power factor correction equipment

Ensure that all power factor correction equipment is of the ratings indicated by the drawings or the relevant 'system' sections of this specification.

Provide for all necessary space, electrical switchgear and controlgear required for any future fit of PFC identified by the drawings or the relevant 'system' sections of this specification.

Use power factor correction equipment compliant to BS EN 61439 and BS EN 61921.

Include detuning reactors within power factor correction equipment in accordance with the manufacturer's recommendations.

Ensure that all capacitors are of the self-healing type conforming to BS EN 60831.

Provide rating markings to power factor correction equipment as per BS EN 60831-1.

Use capacitor banks consisting of individual capacitors wound from a metallized polypropylene film dielectric hermetically encapsulated. Mount capacitor banks in a sheet steel tank. Alternative forms of construction may be offered for consideration by the Contract Administrator.

Ensure that capacitor dielectric losses are less than 1.0 W/kVAr

Fit capacitors with an automatic discharge device to achieve full discharge of capacitors within one minute after disconnection. Ensure that there are no devices capable of isolating the capacitors from the discharge device during the discharge period.

Install suitable current limiting devices to capacitor banks to limit inrush currents on capacitor switching. Ensure that power factor correction control equipment has the following functionality:

- ~ user interface
- ~ automatic disconnection of all capacitors in the event of mains failure, with a two-minute delay before re-connection
- ~ adjustable target power factor setting
- ~ optimization of capacitor switching to minimise inrush currents, minimal switching of capacitors to achieve target power factor, minimise the propagation of voltage transients to the LV supply, and controlled discharge of capacitor before reconnection to supply

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- ~ push-button operated manual override incorporating controlled discharge as above
- ~ adjustable switching programmes
- ~ visible indication of capacitor stages
- ~ metering parameters voltage, current, kvar, power factor

Protect each capacitor stage with HBC fuses of current rating no less than 1.5 times its rated capacity current.

Ensure that every capacitor control contactor is rated for its switching duty.

Ensure that all power factor equipment is automatically disconnected prior to the operation of any standby generator(s).

Fit rating plates to each capacitor assembly as per BS EN 61921 to include, but not limited to, date of manufacture, rated reactive power, rated voltage, frequency, short circuit withstand and IP rating.

270 Harmonic filtering equipment

Ensure that all harmonic filtering equipment is of the ratings indicated by the drawings or the relevant 'system' sections of this specification.

Allow for all necessary space and electrical switchgear and controlgear required for any future fit of harmonic filtering equipment identified by the drawings or the relevant 'system' sections of this specification.

Install and commission all harmonic filtering equipment as per the manufacturer's recommendations.

Provide all harmonic filtering equipment with spares as per the manufacturer's recommendations.

Undertake a field survey for harmonic analysis of all nth harmonics up to and including the 50th. Submit the field survey report to the Contract Administrator within two weeks' of undertaking the survey.

The field survey must be representative of the normal site operations and be of sufficient duration to capture a representative sample of plant and equipment duty cycles.

Install passive harmonic filtering assemblies conforming to BS EN 61439 as indicated by the drawings or the relevant 'system' sections of this specification.

Size and tune passive filters to provide optimum attenuation of harmonics identified for reduction during the field survey.

Install active harmonic filtering equipment conforming to BS EN 61439 as indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that the active harmonic filtering equipment comprises all necessary current transformers, closed loop control technology, and semiconductor power injection devices necessary to deliver the performance identified by the field survey report.

Provide active harmonic filter equipment with a user interface to allow access to:

- ~ stop and start filter
- ~ switch between automatic and manual selection of targeted harmonic frequencies
- ~ set operating parameters
- ~ read operating parameters such as total harmonic distortion, injected harmonic currents
- ~ view waveforms and graphs
- ~ set Modbus/BMS output

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280 Switchboards

281 Cubicle type switchboards

Ensure that all cubicle type switchboards (cubicle panels) are manufactured in accordance with BS EN 61439. Ensure that the cubicle panel maintains BS EN 61439 verification after site assembly and integration into the on-site electrical systems.

Size all cubicle to accommodate the switchgear and to the form indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that all cubicle panels are manufactured with a minimum thickness of 16-gauge zintec-coated braced sheet steel finished with epoxy-based paint on all surfaces and support frames.

Ensure that all cubicle panels are protected to a minimum of IP31 to BS EN 60529.

Ensure that all cubicle panels are fully fault-rated as detailed by the drawings or, if not indicated by drawings, to a minimum level of 50 kA for one second duration.

Ensure that all cubicle panels are of the front-access type unless otherwise indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that all cubicle panels are complete with a 100 mm high metal plinth.

Ensure that all cubicle panels are readily extendible.

Install spare cubicle panels as indicated by the drawings or the relevant 'system' sections of this specification to accommodate the metering equipment etc for the electricity companies.

Provide cubicle panel sections with removable eye bolts in each corner for lifting purposes.

Ensure that all connections between busbars and associated switchgear are adequately rated for load and fault currents.

Enclose cubicle panel busbars in an earthed metal chamber. Ensure that a removable metal cover provides an earthed barrier between the operator and the live connections.

Ensure that all penetrations of live busbars into outgoing circuit compartments or cable chambers are fully shrouded. Ensure that all busbars have a minimum current rating of that of the switchgear controlling the incoming supply to the cubicle panel.

Install a full length and suitably sized earth bar to each panel. Provide bonding connections to each item of switchgear and cable plates.

Control all outgoing circuits using fuse switches, MCCBs or ACBs as indicated by the drawings or the relevant 'system' sections of this specification. To permit the renewal of fuses, ensure that their fuse carrier assemblies are fully isolated when the associated fuse switch is in the OFF position. Ensure that all fuse switches have double-break, silver or electro-tinned contacts, safety interlocks, and ON/OFF indication.

Ensure that all ACBs and MCCBs installed in cubicle panels are I_{cs} (rated service short-circuit breaking capacity) duty as defined in BS EN 60947, and tested within a minimum switchboard enclosure.

Use ACBs conforming to BS EN 60947-3 Utilisation Category AC-23. Use moulded-case circuit breakers conforming to BS EN 60947-2, with the voltage and current ratings, rated duty and rated short-circuit breaking capacity indicated, and a rated short-time withstand time of one second unless otherwise indicated.

Ensure that all ACBs are of the withdrawable pattern each complete with control/ switching devices, interlocks, locks, etc, and safety shutters which completely shroud the main fixed isolating contacts automatically when the breaker section is withdrawn.

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Ensure that all operating handles for switchgear are of the rotary, toggle or retractable types and are manufactured such that the cover cannot be removed while the switch is in the ON position.

Fuse switch units fitted with solid copper links appropriately rated may be used as isolators for circuits up to 1600 A provided they are suitable for the fault duty.

Fit labels to all switchgear, cable chamber covers and busbar covers with the appropriate designations or warning notices as necessary. Issue label schedules to the Contract Administrator for agreement of designation.

282 Unit type switchboards

Ensure that all unit type switchboards consist of switchgear units and fusegear in accordance with this specification section Y71, together with all matching cable boxes, terminations, conduits and wiring interconnections, as indicated by the drawings or the relevant 'system' sections of this specification.

For each unit type switchboard, mount all switchgear and fusegear on a painted mild steel angle frame within the dimensions of the space indicated on the drawings.

Where unit type switchboards are sited over formed floor trenches, supply and fix all necessary support steelwork to span the trenches.

Make all required floor/wall fixings by using plated anchors each having a loose bolt and washer.

Ensure that each busbar chamber spans the whole length of the associated switchboard and is readily extendible. Ensure that all copper busbars are of the minimum rating of the main incoming switch, and suitably colour coded both on the bars and on the chamber cover.

Ensure that all connections between busbars and their respective switchgear and distribution gear are by copper bars, copper rods or copper cables, suitably fixed with clamps and bolts.

Mount suitable cable trunking and matching steel cabinet(s) on the frame to accommodate metering, CTs and other equipment of the local electricity companies where required.

Incorporate instrumentation in accordance with section Y71 and the relevant 'system' sections of this specification, and as indicated by the drawings.

Ensure that each unit type switchboard is complete with protective conductors bonding all components fully in accordance with BS 7671. Provide a main earth terminal. Do not carry out through wiring.

Assemble all unit type switchboards from one manufacturer's equipment with a common finish.

300 SWITCHGEAR AND LV PANELS - GENERAL

310 Drawings

Before manufacture commences submit drawings to the Contract Administrator for comment showing the proposed switchboards, including dimensions, construction details, layout, internal connections and identification markings.

320 Terminations and switchboard connections

Provide the selected manufacturers of LV panels with details of all cable sizes, cable types, switchgear and panel locations, both during tender enquiry and post-tender periods, so that if necessary, panels, switch unit sizes, terminations, etc are properly adjusted to suit the particular project requirements. Include all costs associated with such adjustments in the tender.

Provide all switchgear with suitable means of accepting the types and sizes of connected cables.

Provide connection rail enclosures and cable gland plates for cubicle boards.

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

Ensure that all small wiring within every panel complies with BS 6231 using type 'B', PVC insulated 600V grade stranded copper conductors having a cross section of not less than 1.5 mm².

Terminate wiring on readily accessible fully shrouded terminal rails adjacent to the instruments.

Ensure that terminal markings and conductor identification fully comply with section Y82 of this specification and BS 5472.

Ensure that terminations of voltages in close proximity are segregated by insulated barrier plates.

Ensure that terminal rails are of the appropriate current rating, of sufficient size to suit the cable conductors being installed, are fitted with purpose-made supports, are of robust construction, and further comply with the following:

- ~ the voltage rating is 500 V
- ~ DIN rail mounted
- ~ the terminal fixing to rails has spring-loaded fronts, ie retention is not dependent only on the terminal mouldings
- ~ terminals are locked to the terminal rail
- ~ clamping screws are captive of high-tensile steel and operate against a plate to prevent damage to the conductor. Do not use pinch screws or push-on terminals
- ~ insulation materials are carbon-free non-hygroscopic and suitable for continuous operation at temperatures of -5°C to 130°C
- ~ contain safety features to eliminate accidental contact by any operator

Do not route outgoing cables through the busbar chamber.

Ensure that suitable cable gland plates are fitted to receive the respective cables where vertical cable chambers form part of the panel construction.

Wire to terminal rails all relays, multi-pole contactors, instruments and other components accommodated within panel compartments.

330 Safety and maintenance

Ensure that all remote switch devices used for local isolation have facilities for padlocking the device in the ON or OFF position as appropriate. Ensure that all switches conform to tables I and II of the relevant British Standards.

Ensure that all switchgear specified with Castell interlocks are sequenced correctly and that the correct number of keys is supplied.

340 Identification and notices

Ensure that all identifications and notices comply with section Y82 of this specification and BS 7671.

Fix identification and warning labels of minimum size 75 mm X 25 mm to each item of equipment. Fix all labels with plated screws.

Ensure that all identification labels are white with in-filled black letters 6 mm high.

Ensure that warning labels are white with in-filled red letters 20 mm minimum high.

Ensure that the basic circuit chart for distribution boards is in accordance with BS 7671.

350 Phase colouring

Clearly mark all switchgear and distribution boards on the external vertical face by discs showing the phase. Mark busbars with a coloured tape band.

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Ensure that the phase sequence is maintained along the entire length of each busbar trunking system and is identical in all systems in the installation. Permanently mark phase colours clearly and in each trunking unit.

360 Current transformers

Use current transformers (CT) conforming to BS EN 61869-2.

Use CTs with a 5 A secondary unless otherwise indicated by the drawings or the relevant 'system' sections of this specification.

Ensure that each CT has a rated VA output suitable for the type and magnitude of the connected burden.

Ensure that all CTs for metering and control purposes are of accuracy Class 3 minimum.

Match protection CT secondary excitation characteristics, secondary winding resistance and secondary burden resistance to the protective relay system with which it is used to ensure correct operation of protection relay.

Ensure that the Accuracy Limit Factor (ALF) for 5P and 10P protective CTs is appropriate for the protection scheme, and greater than the highest available setting of any instantaneous element. Ensure that the 'knee' point voltage of Class PX CTs is sufficient for correct operation of the protection scheme and can maintain stability for 'through fault' conditions.

Use current transformers of the 'bar' primary type unless otherwise approved accepted by the Contract Administrator. Match sets of CTs.

Terminate all connections from secondary windings at terminals integral with or adjacent to the CTs. Lace secondary windings and arrange to prevent contact with the 'main' circuit. Earth one terminal of the CT secondary circuit.

Do not insert isolating contacts in circuits between CTs and protective devices.

Ensure that the removal of the protection relay from its case will 'short circuit' the connected CT.

Provide all protection relays with facilities for testing:

- ~ preferred method - direct secondary injection at the relay
- ~ alternative method - a CT with a test winding, and terminals brought out to convenient locations. Arrange every such test winding so that injection of 10 A represents the full load current in the main circuit

All protection relays or electronic protection devices and metering shall be resistant to mains-borne harmonics such that their operation or accuracy is not affected.

All protection relays shall be electronic, programmable protection devices with self-illuminating electronic displays.

Each relay shall have short-circuit and earth fault (both residual and restricted) protection with selective inverse, very inverse, definite time, and instantaneous short circuit tripping facilities.

All protection relays shall be capable of recording and storing a date and time stamped event log.

370 Instruments and metering

Provide all instrumentation and metering as identified by the drawings or the relevant 'system' sections of this specification.

Provide dedicated metering for the measurement of kWh at the locations identified by the drawings.

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

Ensure that all combined performance measuring and monitoring devices that measure and monitor the electrical parameters within electrical distribution systems conform to BS EN 61557-12. Ensure that all energy meters are of the static type, minimum Class 2 accuracy with digital display, and conform to BS 8431 and/or BS EN 62053-21 and/or BS EN 62053-23.

Use meters that operate with a meter supply of 230 V ac at 50 Hz.

Ensure all instruments are:

- ~ flush mounted
- ~ back connected
- ~ provided with means for zero adjustment
- ~ minimum size DIN 72 x 72 panel mounted
- ~ minimal terminal size of M4

Provide multi-function meters with the following functions:

- ~ voltage phase-to-phase
- ~ voltage phase-to-neutral
- ~ voltage total harmonic distortion
- ~ current
- ~ kW
- ~ kVA
- ~ kVAR
- ~ power factor
- ~ frequency

Provide all multi-function meters with pulse output.

Provide all networked meters with Modbus communication output.

Provide HBC fuses to each voltmeter. Provide double insulated cables between the busbars and the meter fuses. Provide single insulated cables between the meter fuses and the meter.

Submit drawings of the location and general arrangement of meters to the Contract Administrator for comment before manufacture commences.

Fit all incoming supply compartments with voltmeters, ammeters or multi-function meters.

Fit all outgoing circuits with ammeters and selector switches as detailed by the drawings.

380 Testing

Submit verification documentation in accordance with BS EN 61439 for all switchgear and controlgear assemblies to the Contract Administrator when the panel and assembly drawings are submitted for comment.

Clearly mark all equipment with the standard to which it complies. Provide type test certificates, for the class of switchgear to be supplied.

Ensure type testing is in accordance with BS EN 60439.

Include in the tender all costs for inspection visits to the manufacturer's works by the Contract Administrator. Give the Contract Administrator two weeks' notice of each test.

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Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

END OF SECTION Y71

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHETSER ROYAL INFIRMARY

Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

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Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including replacement, amendments and normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc.) of this specification, the standard referred to in the engineering system section prevails.

The Electricity (Factories Act) Special Regulations

The Health and Safety at Work etc. Act

The Electricity at Work Regulations

The Electrical Equipment (Safety) Regulations

The Supply of Machinery (Safety) Regulations

BS 88 Low-voltage fuses (Cited in BS 7671 but withdrawn and replaced by BS EN 60269)

BS 89 Direct acting indicating analogue electrical measuring instruments and their accessories.

BS 5992 Electrical relays

BS 7671 Requirements for electrical installations. IET Wiring Regulations

BS EN 55014-1 Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Emission

BS EN 60051-1 Direct acting indicating analogue electrical measuring instruments and their accessories. Definitions and general requirements common to all parts

BS EN 60073 Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators

BS EN 60204-1 Safety of machinery. Electrical equipment of machines. General requirements

BS EN 60255 Measuring relays and protection equipment

BS EN 60269-1 Low-voltage fuses. General requirements

BS EN 60269-4 Low-voltage fuses. Supplementary requirements for fuse-links for the protection of semiconductor devices

BS HD 60269-2 Low-voltage fuses. Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application). Examples of standardized systems of fuses A to J

BS EN 60529 Degrees of protection provided by enclosures (IP code)

BS EN 60947-1 Low-voltage switchgear and controlgear. General rules

BS EN 60947-2 Low-voltage switchgear and controlgear, Circuit breakers

BS EN 60947-3 Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units

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MANCHETSER ROYAL INFIRMARY

Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

BS EN 60947-4-1	Low-voltage switchgear and controlgear. Contactors and motor-starters. Electromechanical contactors and motor-starters
BS EN 60947-4-2	Low-voltage switchgear and controlgear. Contactors and motor-starters. AC semiconductor motor controllers and starters
BS EN 60947-8	Low-voltage switchgear and controlgear. Control units for built-in protection for rotating machines
BS EN 61000-5-7	Electromagnetic compatibility (EMC). Installation and mitigation guidelines. Degrees of protection by enclosures against electromagnetic disturbances (EM code)
BS EN 61000-6-3	Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments
BS EN 61000-6-4	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments
BS EN 61439-1	Low-voltage switchgear and controlgear assemblies. General rules
BS EN 61439-2	Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies
BS EN 61439-6	Low-voltage switchgear and controlgear assemblies. Busbar trunking systems (busways)
BS EN 61800-2	Adjustable speed electrical power drive systems. General requirements. Rating specifications for low voltage adjustable frequency a.c. power drive systems
BS EN 61800-3	Adjustable speed electrical power drive systems. EMC requirements and specific test methods
BS EN 61810-1	Electromechanical elementary relays. General requirements
BS EN 62208	Empty enclosures for low-voltage switchgear and controlgear assemblies. General requirements
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
ENA ER G5/4	Planning Levels for harmonic Voltage Distortion and the Connection of Non-Linear Equipment to Transmission Systems and Distribution Networks in the United Kingdom

200 GENERAL

This specification applies to:

- ~ motor starters and controllers
- ~ all control panels and / or enclosures housing electrical switchgear and controlgear used with all forms of mechanical plant

Ensure that all cable terminals are correctly sized to accommodate the tails of cables specified. Ensure there is ample space within panels, isolators, etc to accept the cables specified.

Protect equipment against physical damage and from ingress of water, dust and other contaminants during delivery, storage and installation.

Install the motor starters, motor controllers, control panels and all interconnected equipment to form a complete and working system. Co-ordinate the designs of all interconnected units, their wiring and terminal connections so that they are mutually compatible and function as a whole in accordance with the design intent.

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Ensure that the cable access systems required are adequately sized, supported and spatially co-ordinated with other equipment and the building structure.

Design and manufacture all purpose-built assemblies incorporating motor control gear and associated equipment and components to comply with the standards referred to in this specification and with the component manufacturers' recommendations.

300 PRODUCTS AND MATERIALS

310 Control panels

311 General

Comply with the motor control centres / control panels requirement of W60.

Design, construct and install control panels, associated switchgear and controlgear assemblies in accordance with BS EN 61439. Submit BS EN 61439 verification documentation to the Contract Administrator when the panel and assembly drawings are submitted for comment.

Fit each assembly with a durable legible label located in a clearly visible place. Provide the following information:

- ~ manufacturer's name or trade mark
- ~ type designation or identification number or other means of identification
- ~ date of manufacture
- ~ IEC 61439-X (the specific part "X" shall be identified)

Prepare schematic, wiring and general arrangement drawings of the control panels and all equipment connected and submit the drawings to the Contract Administrator for comment at least four weeks before manufacture is required to begin. Include details of the motor drives finally ordered. Ensure drawings are A3 size or larger.

Ensure that it is possible, without taking off covers or disturbing the wiring, to safely measure motor current for commissioning purposes with a suitable clip-on ammeter.

Equip the spare compartments with switch/fuses sized for each compartment's maximum capacity. Provide a distribution of spare compartment sizes to match that of the installed drives and packaged plant.

312 Construction

Construct the motor control panels with rigid framed enclosures and with panels in zinc-coated mild steel at least 1.6mm thick for panels up to 600mm x 600mm and at least 2mm thick for larger panels. Round all edges and corners to a minimum radius of 3mm. Passivate the panels and finish all surfaces with a wear resistant paint system in the maker's standard colour.

Provide details of the proposed panel construction and paint system with the drawings submitted to the Contract Administrator for comment.

Design and construct the panels containing motor starters and controllers with protection to IP54 where mounted internally and with protection to IP65 where mounted externally. Design the panels for continuous operation. Size and/or ventilate all panels to maintain all internal components within their maker's specified temperature limits in local ambient temperatures up to 40°C.

Mount proprietary equipment such as inverters and motor soft starters in accordance with their manufacturers' recommendations. Ensure that heat generated can be safely dissipated.

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Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

Fit control panels containing inverters or motor soft starters with temperature detectors to warn when the panel limiting temperature is reached.

For panels weighing more than 40kg provide four removable lifting eye bolts on the top of each panel. Provide blanking plugs to seal the holes when the lifting eyes are removed.

Assemble floor-mounted units on a plinth at least 100mm deep made of channel iron or zinc-coated sheet steel, with holes provided to bolt the complete assembly to the floor. Provide all necessary packing and / or grouting to ensure the plinth is fixed on a firm level surface. Limit the maximum height of floor-standing units to 2m above the plinth.

Ensure that the panel dimensions, particularly the height, do not prevent proper installation of the panel and of the cables and cable access systems associated with it.

Do not mount any live panel components on the floor, roof or sides of the panel, or less than 150mm from the bottom of the panel.

Provide panel doors with lockable hand-operated fastenings and a minimum of three keys per fastening.

Fit appropriately rated anti-condensation heaters which are automatically energised when the panel is switched off. Fit clearly legible warning label in prominent position near each anti-condensation heater with the following warning: "Power to anti-condensation heater is supplied from a separate source. Ensure that power is isolated and locked off before servicing."

313 Wardrobe-type control panels

Construct wardrobe type control panels to BS EN 61439-2 with separation as per National Annex NA to the Form Types specified in specification section W63.

Mount all main components on a back plate. Mount switches, instrumentation and indicator lamps on the front panel doors. Ensure that all live parts are efficiently shrouded against accidental contact during maintenance or inspection.

Supply power to all motor drives and packaged plant via fuses to BS 88 / BS EN 60269.

314 Compartmented control panels

Equip each compartment with the following equipment and controls as appropriate:

- ~ ~ fuse/switch isolator
- ~ ~ ammeter
- ~ ~ control switches and indicator lamps
- ~ ~ motor starters
- ~ ~ sub-fuses for the low speed windings of motors with separate windings
- ~ ~ door lock
- ~ ~ labels and warning notices

315 Electrical requirements

Design the internal busbar system, including its fixings within the assembled panel, to carry the full load current scheduled in the particular specification and a 3-phase symmetrical short-circuit current of 30kA for 1 second.

Design all equipment and wiring for 50Hz electrical supplies of 400V (3 ph) or 230V (1 ph) plus 10% or minus 6%.

Design and construct all electrical equipment to be suitable for use in local ambient temperatures up to 40°C and with relative humidities up to 90% with occasional occurrences of moderate condensation,

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unless specified otherwise in specification section V20. Proof all equipment against moderate amounts of dust and, where required, against corrosion by salt laden air. Use only materials resistant to mould growth and attack by vermin.

Protect all connecting cables against overload and short-circuit faults by appropriately sized fuses to BS 88 / BS EN 60269. Select fuses protecting motor circuits to suit the motors to be finally installed according to the fuse manufacturer's recommendations for the type of motor starting employed.

Ensure that all cable glands and conduit entries maintain the integrity of the IP protection rating specified. Ensure that all cables entries from trunking are made via a purpose made watertight upstand of sufficient height to form a water resistant junction between the panel and the cable trunking.

Terminate all incoming and outgoing cables in terminal blocks close to the cable entry positions. Terminate control cables carrying voltages of 110V and above in disconnectable terminal blocks for essential working without isolating the main supplies, using appropriate safety procedures.

Ensure all fuses installed in the motor control panel provide satisfactory discrimination with sub-circuit fuses within the panel and with the panel's main supply fuse. Submit discrimination study to the Contract Administrator for comment.

Shroud all cable terminals, live parts of the switchgear and other components, including live parts to the rear of switchgear, against accidental direct contact when testing and inspecting the panel. Install fuses either as part of fuse/switches or in shrouded fuse holders.

Identify and mark all cables, cable terminals, fuses, switchgear and other components with permanent labels using the circuit references used in the installation and on Record Drawings.

Connect all motor control panels to a main low voltage switch board as per the Electrical Distribution Schematic.

Ensure that all internal cableways and terminal blocks are sized to accept the input and output cables specified. Submit details of the maximum proposed incoming and outgoing cable termination capacities in conjunction with their panel drawings for comment by the Contract Administrator prior to panel manufacture.

Loosely loom all internal wiring in slotted plastic trunking. Ensure all wiring is free from mechanical strain and protected from abrasion or other mechanical damage. Size all wiring to be protected against both overload and short circuits by the fuses installed. Incorporate extra space in the panels for terminals, fuseways and starters up to one-quarter of the installed capacity.

316 Monitoring instrumentation

Equip each panel with the following instrumentation:

- ~ a fuse protected incoming supply voltmeter of 0-500V range with a line and phase voltage selector switch
- ~ an incoming ammeter with phase selector switch. The full scale reading of the meter shall be the rating of the fuses protecting the panel
- ~ an ammeter for each motor drive and packaged plant unit of 15kW and above

Ensure all instruments are at least 70mm square, with scales over a 90° arc and conforming to BS 89. Provide motor and packaged plant ammeters with full scale readings twice the full load current of the equipment served. Ensure ammeters are capable of passing starting currents without damage.

317 Earthing

Install an earthing bar of 25 x 3mm copper along the whole length of each panel.

Connect each panel section, including the panel doors and circuit protective conductors to the earthing bar via connections sized to comply with BS 7671.

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318 Panel isolation

Route the incoming supply via a separate full-load rated three-pole isolator mounted so that it can be operated with the panel doors open or closed.

Take the building management system from the live side of the panel isolator via separately mounted fuse/switches, or from a separate secure supply.

320 Motor starters and controllers

321 General

Provide motor starters of the type specified in this specification to start and accelerate motors to normal speed and to ensure continuous operation of motor. Ensure motor starters can switch off the supply from the motor and also provide protection of motors and associated circuits against operating overloads.

Ensure that the levels of harmonic emissions from soft-starters, inverters and other non-linear loads do not exceed the planning levels specified in ENA ER G5/4. Provide, install and commission all passive and / or active filters as necessary to reduce all excessive harmonic emissions to a level in compliance with G5/4.

Prepare schematic, wiring and general arrangement drawings of the motor starters, controllers and all equipment connected and submit the drawings to the Contract Administrator for comment at least four weeks before manufacture is required to begin. Produce the drawings at A3 size and include final details of all the motors ordered.

Schedule the details of all motors and packaged plant ordered and ensure that the wiring, fuse protection, starter contactors, overload relays and all other circuit elements are correctly selected according to the requirements of this specification, the documents referred to above and the component manufacturer's published application data.

Apply the following starting methods for all IE3 rated motors:

- ~ Direct-on-line is permissible for motor drives below 5.5kW
- ~ Fit motor drives of 5.5kW output and above with Star/Delta starters, or with such other form of assisted starting as is scheduled in the particular specification
- ~ Fit motor drives with outputs above 22kW, if suitable for star/delta starting, with closed-transition Star/Delta starting, Electronic Soft Start or Variable Speed Drive Controllers as specified in the equipment schedules

Apply the following starting methods for all IE2 rated motors installed before 1 January 2017:

- ~ Direct-on-line is permissible for motor drives below 5.5kW
- ~ Fit motor drives between 5.5kW and 7.5kW output with Star/Delta starters, or with such other form of assisted starting as is scheduled in the particular specification
- ~ Fit motor drives with outputs above 7.5kW with Variable Speed Drive Controllers

Apply the following starting methods for all IE2 rated motors for all motors installed on or after 1 January 2017:

- ~ Direct-on-line is permissible for motor drives below 0.75kW
- ~ Fit motor drives with outputs above 0.75kW with Variable Speed Drive Controllers

Arrange for motor starters and drives to open in the event of power interruption and to remain open until deliberately restarted in the normal manner.

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Ensure that motor drives with hand controls only can be restarted by hand. Fit motor drives subject to automatic control with automatic sequencing arranged to ensure that the drives are restarted in correct sequence and without overloading the main supply system.

Design automatic controls so as not to allow motor drives to be started more frequently than once every ten minutes unless a lesser interval between motor starts is allowed by the particular specification.

Where Duty 1 and Duty 2 motors are provided for the same item of plant, hard-wire interlock the associated starters to prevent simultaneous operation.

Where two-speed motors are fitted with separate windings for each speed provide a separate starter for each speed. Hard-wire interlock the starters to prevent simultaneous operation, with a time delay relay fitted to provide an adjustable pre-set delay of up to 10 seconds when switching from High to Low speed.

322 Contactors and overload protection

Install motor starters which comply with appropriate parts of BS EN 60947 and include the following features:

- ~ contactors rated for continuous duty, Category AC-3 and sized to carry at least the maximum continuous current they are required to carry with the motor or other equipment served at full load plus 10%
- ~ thermal-magnetic overloads chosen to suit the motors and starter connections finally selected, compensated for ambient temperature and with loss-of-phase protection. Ensure the units incorporate manual reset, local visual fault indication and auxiliary contacts for remote fault indication
- ~ individual protection against short circuits by fuses to BS 88 / BS EN 60269. Select the contactor and fuse combination to provide Type 'C' protection co-ordination to BS EN 60947-1. Ensure that a short-circuit fault downstream of the motor starter causes no damage to starter
- ~ thermistor protection units for those motors for which thermistor protection is specified elsewhere. Ensure the units comply with BS EN 60947-8 and incorporate manual reset, LED fault signalling and a test button to check correct operation
- ~ auxiliary contacts for the control and signalling functions specified elsewhere

323 Direct-on-line (DOL) motor starters

Install direct-on-line motor starters embodying the following features:

- ~ a single contactor
- ~ thermal-magnetic overload set for the motor rated full load current

324 Star/delta (S/D) motor starters

Install star/delta motor starters embodying the following features:

- ~ three contactors: line, delta and star
- ~ mechanical interlock between the delta and star contactors to prevent simultaneous operation
- ~ variable time delay for change from star to delta of 5 to 20 seconds. Set the delay time so that the change from star to delta takes place after the motor current has fallen to a value less than rated full load
- ~ ensure that the time delay to making of the delta contactor allows sufficient time for the star contactor to break

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- ~ thermal-magnetic overload set for the motor rated full load current
- ~ auxiliary contact signal from motor local isolator switch to signal that motor starter should be switched off when switch is open

325 Closed-transition star/delta motor starters

Install closed-transition star/delta motor starters embodying the following features:

- ~ four contactors: line, delta, star and resistance, all sized for the load current carried plus 10%
- ~ a resistor in series with each winding, rated for up to 5 seconds on load
- ~ mechanical interlock between the delta and star conductors to prevent simultaneous operation
- ~ variable time delay for the time in star connection of 5 to 20 seconds. Set the delay time so that the change from star to resistance takes place after the motor current has fallen to a value less than rated full load
- ~ variable time delay for the time with the resistors in series with the windings of 0.5 to 1.5 seconds. Set the delay time so that the resistors remain in series with the motor windings until the motor current has fallen to a value less than rated full load
- ~ short out then disconnect the resistors at the expiration of the 0.5 to 1.5 seconds time delay
- ~ thermal-magnetic overload set for the motor rated full load current
- ~ auxiliary contact signal from motor local isolator switch to signal that motor starter should be switched off when switch is open

326 Electronic soft starters

Provide electronic soft-starters sized by their manufacturer to suit the motors finally ordered. Allow for the motors to operate continuously at their maximum continuous rating (Duty S1).

Fit input/output filters if required to reduce mains harmonic distortion or to keep electromagnetic radiation within acceptable limits. Fit varistors or equivalent input device to prevent damage to the unit by mains over-voltage spikes.

Mount the soft starters as detailed in specification section W63, and provide the following control facilities:

- ~ adjustable acceleration ramp up to 30 seconds
- ~ adjustable current limit from 2 to 5 times full load current
- ~ combined acceleration ramp and current limit to control starting torque
- ~ motor thermal overload protection and early warning indication
- ~ fault detection, diagnostic facilities and alarm signalling to the BMS
- ~ shorting / bypass contactor for use with motor drives where energy saving is ineffective
- ~ starter trip and reset to OFF on loss of power supplies

Submit the following details of the proposed soft-starter to the Contract Administrator for comment before ordering:

- ~ maker's specification and literature
- ~ proposed starter mounting details

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Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

- ~ proposed wiring and connection details, including control connections
- ~ proposed commissioning and adjustment procedure

330 Motor drives

331 Variable frequency inverter drives

Provide stand-alone (ie separate from motor) inverter drives or combined (close coupled) or separate inverter and motor drives, as specified in specification section W63, sized by the inverter manufacturer to match the motors finally ordered.

Install inverter and combined inverter and motor drives in accordance with manufacturer's recommendations. Ensure that the installation meets the manufacturer's cooling and vibration recommendations.

Ensure inverter drives for fans and pumps maintain a constant voltage / frequency ratio at frequencies below 50Hz. Provide confirmation that the motors and inverter units finally selected are suitable for the required duty, including any allowance for motor de-rating specified by the motor manufacturer.

Select the motor drive pulley sizes so that the motors deliver their selected maximum output with the inverter output at 50Hz. Provide inverters whose minimum inverter frequency is 10Hz and the maximum 57.5Hz, or the frequency at which the motor is delivering full power, whichever is the lesser.

Ensure that the inverter drive starts the motor and its load within the time constraints recommended by the motor / equipment manufacturer.

Provide the following inverter control facilities:

- ~ power supply via BS 88 / BS EN 60269 fuses of a size specified by the inverter manufacturer and a local isolating switch to disconnect all power from the inverter and motor when required
- ~ inverter power input circuits protected against mains voltage short duration spikes of up to 2 kilovolts
- ~ initiate drive start by signal from the building management system or locally by a panel mounted Hand/Off/Auto switch or otherwise
- ~ drive frequency controlled by a 0-10V signal from the building management system, or by local panel mounted inverter frequency control
- ~ a frequency display, either digital or analogue scaled 0-60Hz
- ~ protection against inverter overheating, motor over current, external short circuits, motor single phasing and earth faults
- ~ simple fault diagnosis facilities and a common fault signal to the building management system
- ~ where the inverter is mounted remotely from the motor drive provide a local steel cased isolator with early-break contact to shut down the inverter, for motor maintenance
- ~ user programmable functionality

Provide for the following relay outputs rated at 240V AC, 2A from the inverter:

- ~ inverter running
- ~ inverter alarm

Where specified in system specifications provide for the following digital outputs rated at 24V DC, 40mA from the inverter:

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- ~ inverter running
- ~ inverter fault
- ~ inverter ready
- ~ motor current outside specified range
- ~ motor speed outside specified range
- ~ thermal warning
- ~ drive in hand mode
- ~ drive in auto mode
- ~ inverter operating in fire/smoke mode (inverter will keep running irrespective of its normal protective functions)

Where specified in system specifications provide for the following digital inputs rated at 24V DC, at the inverter:

- ~ go to preset speed 1
- ~ go to preset speed 2
- ~ go to preset speed 3
- ~ fire / smoke mode enable
- ~ drive start

Where specified in system specifications provide for the following analogue inputs rated at 0-10V DC or 0/4-20mA selectable:

- ~ variable frequency / motor speed reference

Where specified in system specifications provide for the following analogue outputs rated at 0-10V DC or 0/4-20mA selectable:

- ~ inverter frequency / motor speed

Where required in W66 provide energy consumption data in kWh to metering, monitoring and management systems.

Where communication with the inverters is specified in system specifications or noted on drawing provide RS 485 datalink communication interface suitable for communication using BACnet, Modbus, Lonworks, Ethernet/IP or other protocol as specified.

Where the inverter/motor system is not provided as an integrated and matched system ensure that the inverter and the motor are compatible over the full range of design operating conditions.

Install an electromagnetic interference (EMI) filter in the supply line to the inverter and in the output terminals from the inverter to manage the effects of harmonic distortion on the mains supply within acceptable limits in accordance with the manufacturer's recommendation. Check with the inverter and motor manufacturers as to whether a surge suppressor is required to be installed between the inverter drive and the motor and install one if required.

Use only 12-pulse rectifiers for inverter drives serving motors of 132kW or more to reduce generation of low frequency harmonics.

Submit the following details of the proposed variable frequency inverter drive to the Contract Administrator for comment before ordering:

- ~ maker's specification and literature

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- ~ proposed drive, starter and controller mounting details
- ~ proposed wiring and connection details, including control connections
- ~ proposed commissioning and adjustment procedure

340 Motor control panels

Ensure that motor control panels comply with all the requirements specified in clause 310 except where modified or added to by the requirements specified under clause 330.

341 Motor circuit wiring

Unless specified differently elsewhere, install wiring types as scheduled below:

Wiring Type	Application
PVC/SWA/XLPE, 600/1000V grade, insulated and sheathed, with stranded copper conductors, run on cable tray or clipped direct.	Connections to main LV switchboard, motor drives, control devices operating at 230V.
PVC insulated, 600/1000V grade, stranded copper conductors.	Control panel internal power wiring.
Screened and sheathed twisted pairs with stranded copper conductors as specified by controls specialist.	Connections to sensors, instrumentation and motorised valves operating at voltages less than 230V.
Inverter manufacturer specified motor feed cable where specified OR multicore, XLPE insulated, symmetrical with full size ground, braided / foil screened and suitable for inverter motor feed cable.	Motor feed cable.

Ensure that all wiring, except that specified by controls specialist, meets the requirements of BS 7671 and is of a minimum size of 1.5mm².

Submit full cable sizing calculations to meet BS 7671 for all plant supply cabling for the Contract Administrator's comment.

Use crimped lugs by AMP or equivalent for all minor cable terminations, with the cable insulation secured at the termination by a crimped plastic skirt. Prepare cable terminations in accordance with the crimp manufacturer's instructions and using the tools specified. Leave sufficient lengths on cables to ensure there is no tension on any connection.

342 Control circuits

Design control circuits for operation of contactors at 230V. Size control circuit wiring to be at least 1.5mm² and so that voltage drop even during motor starting is never great enough to prevent correct operation of all devices served.

343 Control relays

Install control relays of the plug-in type which shall conform to BS EN 55014-1 and BS 5992 with contacts rated for operation up to 230V, 5A, 50Hz.

Enclose control relays in dust proof covers.

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Y72 CONTROL PANELS, MOTOR STARTERS AND CONTROLLERS

344 Control switches

Provide front panel rotary switches for the following duties:

- ~ single speed, single motor drives: HAND/OFF/AUTO.
- ~ two-speed motor drives: HIGH SPEED/LOW SPEED/OFF/AUTO
- ~ motor drives with Duty 1 and Duty 2 motors: DUTY 1/DUTY 2 selector switch for use when the motors are in hand control with HAND/OFF/AUTO selector switches for each drive

Arrange for all selector switches serving plant subject to AUTO control to have auxiliary contacts to signal to the building management system when the drives are in auto control.

345 Lamp indications

Provide indicator lamps of uniform luminance and a viewing angle in excess of 120 degrees for the following functions for each drive served:

- ~ RUN: Green Lamp
- ~ TRIPPED: Red Lamp
- ~ PANEL LIVE (EACH SECTION): White Lamp
- ~ SUPPLY ON (PACKAGED PLANT): White Lamp

Install LED indicator lamps powered by extra low voltage drivers with integral current limiting functionality and reverse polarity protection. Provide a push-to-test facility. Ensure LEDs are replaceable without the use of special tools and are of an industry standard size and fitting.

346 Panel labels for information and warning

Fix permanent engraved labels to all panels to provide information and warning to suitably qualified persons carrying out operation and maintenance:

- ~ a label indicating the function of each switch and lamp indication
- ~ a label on each openable panel door reading: "WARNING - ISOLATE PANEL BEFORE MAINTENANCE". In addition, a self-adhesive warning label is to be fixed to each door giving access to 400 volt circuits
- ~ a key diagram showing the source and identification of all power supplies entering a panel, their function and means of isolation

347 Motor isolation

Provide all motor drives with local isolators for safe mechanical and electrical maintenance of the drives served, including motor drives within packaged plant.

Install isolators with metal cases, protected to IP54 and with early-break contacts to trip the drive starters where assisted start is provided.

Fit a permanent engraved label near each motor drive to read: "ISOLATE MOTOR BEFORE MAINTENANCE".

348 Stand-alone motor starters

Mount stand-alone motor starters in type-tested steel enclosures protected to IP54.

Equip the starters with the following equipment and controls as appropriate:

- ~ panel isolating switch
- ~ ammeter

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- ~ HAND/ OFF/ AUTO and SPEED control switch
- ~ Motor Run (Green) and Trip (Red) indicating lamps
- ~ motor starter
- ~ labels and warning notices

Ensure that it is possible to measure motor current safely with a suitable clip-on ammeter for commissioning purposes.

349 Electromagnetic interference

Install measures to prevent electromagnetic interference with control panel operation and to prevent electromagnetic interference from control panels affecting other electrical equipment. Measures likely to be required include:

- ~ supply motor control panels direct from the main LV switchboard
- ~ wire control systems in twisted pair cable. Segregate control cables from mains cables in accordance with BS 7671
- ~ use armoured cables for power circuits and full-size neutral conductors
- ~ fit voltage surge suppression devices to mineral insulated cables, relay and contactor operating coils and vulnerable electronic equipment
- ~ fit input and output harmonic filters to electronic inverters and motor soft starters
- ~ use of manufacturer's recommended cable for inverter motor feed cable

400 FIXING TO BUILDING 'FABRIC'

Comply with section Y90 of this specification.

500 IDENTIFICATION OF ELECTRICAL SERVICES

Comply with section Y82 of this specification.

600 INSPECTION, TESTING AND COMMISSIONING

Comply with specification section Y81.

Before dispatch undertake verification by testing to BS EN 61439. Provide documentation of all verification undertaken to BS EN 61439 to the Contract Administrator.

Allow time in the programme and attendance for the Contract Administrator to inspect the control panels, before delivery, at the maker's works on completion of manufacture and test. Give ten working days' notice of readiness for inspection.

Ensure that the panels are clean of debris and that all holes are properly sealed.

Check the functioning of all components and controls for correct operation including the correct functioning of all interfaces with associated equipment. Immediately rectify all mal-function and re-check to confirm correct operation. Measure and record power wiring insulation and earth fault loop impedance.

Following installation on site and completion of all site tests, allow programme time and provide attendance for the Contract Administrator to inspect the installation and to verify test results.

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Arrange for special units, such as variable frequency inverters, to be checked and commissioned by the manufacturers, or according to the makers' specific instructions for the units fitted.

Measure and record all motor currents. Set motor overloads to motor nameplate full load currents. Note that star/delta starters normally have overloads installed in the delta load and set to full load current x 0.58

Ensure that during commissioning and testing, no motor that has reached normal operating temperature is started more frequently than twice in one hour, or according to motor manufacturer's recommendations if different.

700 RECORD DRAWINGS, OPERATION AND MAINTENANCE MANUALS

Provide three copies of the following documents bound into durable hardback folders:

- ~ description of equipment operation
- ~ schematic and wiring diagrams and panel general arrangement drawings
- ~ inspection and test certificates
- ~ data sheets and manufacturers' addresses for all panel components
- ~ recommended spares list
- ~ schedule of recommended periodic inspection and maintenance, including safety precautions

800 SCHEDULE OF INSTALLER'S SUBMISSIONS

Submit the following drawings and documents in connection with the motor starters and controllers specified above.

- ~ control panel and assemblies verification documentation to BS EN 61439
- ~ details of discrimination studies and cable sizing calculations
- ~ control panel schematic and general arrangement drawings
- ~ details of control panel construction and finish
- ~ details of control panel labels and key diagrams
- ~ control panel works test certificates
- ~ control panel site testing and commissioning results
- ~ control panel record drawings and operation & maintenance manuals
- ~ details of proposed soft starter, and variable frequency drive

END OF SECTION Y72

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MANCHETSER ROYAL INFIRMARY

Y73 LUMINAIRES AND LAMPS

Y73 LUMINAIRES AND LAMPS

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	272	LED modules
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IMPORTANT NOTICE

Not all of the lamp types included in this reference specification may be appropriate to the project. Refer to the individual system specifications and the luminaire schedule for particular project requirements.

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

BS 67	Specification for ceiling roses
BS 476-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
BS 559	Specification for the design and construction of signs for publicity, decorative and general purposes
BS 1362	Specification for general purpose fuse links for domestic and similar purposes (primarily for use in plugs)
BS 1363	13 A fused plugs, socket-outlets, adaptors and connection units
BS 1853-2	Tubular fluorescent lamps for general lighting service. Specification for lamps used in the United Kingdom not included in BS EN 60081, BS EN 60901, BS EN 61195 and BS EN 61199
BS 4533-102.19	Luminaires. Particular requirements. Specification for air-handling luminaires (safety requirements)
BS 5266-1	Emergency lighting. Code of practice for the emergency lighting of premises
BS 5499-4	Safety signs. Code of practice for escape route signing
BS 5733	General requirements for electrical accessories. Specification.
BS 6972	Specification for general requirements for luminaire supporting couplers for domestic, light industrial and commercial use
BS 7211	Electric cables. Thermosetting insulated and thermoplastic sheathed cables for voltages up to and including 450/750 V, for electric power and lighting and having low emission of smoke and corrosive gases when affected by fire
BS 7629-1.	Electric cables. Specification for 300/500 V fire resistant, screened, fixed installation cables having low emission of smoke and corrosive gases when affected by fire. Multicore cables
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS 7693	Guide to uses of infra-red transmission and the prevention or control of interference between systems
BS 7895	Specification for bayonet lamp holders with enhanced safety

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BS 8519	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications
BS 9999	Fire safety in the design, management and use of buildings
BS EN 40-1	Lighting columns. Definitions and terms
BS EN 40-2	Lighting columns. General requirements and dimensions
BS EN 40-3-1	Lighting columns. Design and verification. Specification for characteristic loads
BS EN 40-3-2	Lighting columns. Design and verification. Verification by testing
BS EN 40-3-3	Lighting columns. Design and verification. Verification by calculation
BS EN 40-4	Lighting columns. Requirements for reinforced and prestressed concrete lighting columns
BS EN 40-5	Lighting columns. Requirements for steel lighting columns
BS EN 40-6	Lighting columns. Requirements for aluminium lighting columns
BS EN 40-7	Lighting columns. Requirements for fibre reinforced polymer composite lighting columns
BS EN 81-71	Safety rules for the construction and installation of lifts. Particular applications to passenger lifts and goods passenger lifts. Vandal resistant lifts
BS EN 12193	Light and lighting. Sports lighting
BS EN 12464-1	Light and lighting. Lighting of work places. Indoor work places
BS EN 12464-2	Light and lighting. Lighting of work places. Outdoor work places
BS EN 13032-1	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format
BS EN 13032-2	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for indoor and outdoor work places
BS EN 13032-3	Measurement and presentation of photometric data of lamps and luminaires. Presentation of data for emergency lighting of work places
BS EN 13032-4	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. LED lamps, modules and luminaires
BS EN 50107-1	Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. General requirements
BS EN 50107-2	Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. Requirements for earth-leakage and open-circuit protective devices
BS EN 50107-3	Product standard covering luminous signs with discharge lamps and/or LED (light emitting diodes) and/or EL (electroluminescent) lightsources with a nominal voltage not exceeding 1000 V, with the exclusion of general lighting, traffic- or emergency related purpose.
BS EN 50525 (All Parts)	Electric cables - Low voltage energy cables of rated voltages up to and including 450/750 V
BS EN 62931:	GX16t-5 capped tubular ledLED lamp. Safety specifications
BS EN 55014-1	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Emission

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BS EN 55014-2	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus. Immunity. Product family standard
BS EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
BS EN 60061-1	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lamp caps
BS EN 60061-2	Lamp caps and holders together with gauges for the control of interchangeability and safety. Lampholders
BS EN 60061-3	Lamp caps and holders together with gauges for the control of interchangeability and safety. Gauges
BS EN 60061-4	Lamp caps and holders together with gauges for the control of interchangeability and safety. Guidelines and general information
BS EN 60064	Tungsten filament lamps for domestic and similar general lighting purposes. Performance requirements
BS EN 60079-0	Explosive atmospheres. Equipment. General requirements
BS EN 60079-1	Explosive atmospheres. Equipment protection by flameproof enclosures "d"
BS EN 60079-2	Explosive atmospheres. Equipment protection by pressurized enclosure "p"
BS EN 60079-5	Explosive atmospheres. Equipment protection by powder filling "q"
BS EN 60079-6	Explosive atmospheres. Equipment protection by liquid immersion "o"
BS EN 60079-7	Explosive atmospheres. Equipment protection by increased safety "e"
BS EN 60079-10-1	Explosive atmospheres. Classification of areas. Explosive gas atmospheres
BS EN 60079-10-2	Explosive atmospheres. Classification of areas. Explosive dust atmospheres
BS EN 60079-11	Explosive atmospheres. Equipment protection by intrinsic safety "i"
BS EN 60079-13	Explosive atmospheres. Equipment protection by pressurized room "p" and artificially ventilated room "v"
BS EN 60079-14	Explosive atmospheres. Electrical installations design, selection and erection
BS EN 60079-15	Explosive atmospheres. Equipment protection by type of protection "n"
BS EN 60079-17	Explosive atmospheres. Electrical installations inspection and maintenance
BS EN 60079-18	Explosive atmospheres. Equipment protection by encapsulation "m"
BS EN 60079-20-1	Explosive atmospheres. Material characteristics for gas and vapour classification. Test methods and data
BS EN 60079-25	Explosive atmospheres. Intrinsically safe electrical systems
BS EN 60079-26	Explosive atmospheres. Equipment with Equipment Protection Level (EPL) Ga
BS EN 60079-28	Explosive atmospheres. Protection of equipment and transmission systems using optical radiation
BS EN 60079-31	Explosive atmospheres. Equipment dust ignition protection by enclosure "t"
BS EN 60079-32-2	Explosive atmospheres. Electrostatics hazards. Tests
BS EN 60081	Double-capped fluorescent lamps. Performance specifications
BS EN 60188	High-pressure mercury vapour lamps. Performance specifications
BS EN 60192	Low pressure sodium vapour lamps. Performance specification
BS EN IEC 60238	Edison screw lampholders

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BS EN 60357	Tungsten halogen lamps (non-vehicle). Performance specifications
BS EN 60400	Lampholders for tubular fluorescent lamps and starterholders
BS EN 60529	Degrees of protection provided by enclosures (IP code)
BS EN 60570	Electrical supply track systems for luminaires
BS EN 60598-1	Luminaires. General requirements and tests
BS EN 60598-2-2	Luminaires. Particular requirements. Recessed luminaires
BS EN 60598-2-3	Luminaires. Particular requirements. Luminaires for road and street lighting
BS EN 60598-2-5	Luminaires. Particular requirements. Floodlights
BS EN 60598-2-6	Luminaires. Particular requirements. Luminaires with built-in transformers for filament lamps
BS EN 60598-2-11	Luminaires. Particular requirements. Aquarium luminaires
BS EN 60598-2-13	Luminaires. Particular requirements. Ground recessed luminaires
BS EN 60598-2-14	Luminaires. Particular requirements. Luminaires for cold cathode tubular discharge lamps (neon tubes) and similar equipment
BS EN 60598-2-18	Luminaires. Particular requirements. Luminaires for swimming pools and similar applications
BS EN 60598-2-20	Luminaires. Particular requirements. Lighting chains
BS EN 60598-2-21	Luminaires. Particular requirements. Rope lights
BS EN 60598-2-22	Luminaires. Particular requirements. Luminaires for emergency lighting
BS EN 60598-2-23	Luminaires. Particular requirements. Extra low voltage lighting systems for filament lamps
BS EN 60598-2-24	Luminaires. Particular requirements. Luminaires with limited surface temperatures
BS EN 60598-2-25	Luminaires. Particular requirements. Luminaires for use in clinical areas of hospitals and health care buildings
BS EN 60630	Maximum lamp outliners for incandescent lamps
BS EN 60730-2-3	Automatic electrical controls for household and similar use. Particular requirements for thermal protectors for ballasts for tubular fluorescent lamps
BS EN 60838-1	Miscellaneous lamp holders. General requirements and tests
BS EN 60838-2-1	Miscellaneous lampholders. Particular requirements. Lampholders S14
BS EN 60838-2-2	Miscellaneous lampholders. Particular requirements. Connectors for LED-modules
BS EN 60838-2-3	Miscellaneous lampholders. Particular requirements. Lampholders for double-capped linear LED lamps
BS EN 60901	Single-capped fluorescent lamps. Performance specifications
BS EN 60921	Ballasts for tubular fluorescent lamps. Performance requirements
BS EN 60923	Auxiliaries for lamps. Ballasts for discharge lamps (excluding tubular fluorescent lamps). Performance requirements
BS EN 60927	Auxiliaries for lamps. Starting devices (other than glow starters). Performance requirements
BS EN 60929	AC and/or DC-supplied electronic control gear for tubular fluorescent lamps. Performance requirements

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BS EN 60947 (All Parts)	Low-voltage switchgear and control gear
BS EN 60968	Self-ballasted lamps for general lighting services. Safety requirements
BS EN 60969	Self-ballasted lamps for general lighting services. Performance requirements
BS EN 61000-3-2	Electromagnetic compatibility (EMC). Limits. Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)
BS EN 61000-4-5	Electromagnetic compatibility (EMC): Testing and measurement techniques – Surge immunity test
BS EN 61047	D.C. or A.C. supplied electronic step-down convertors for filament lamps. Performance requirements
BS EN 61048	Auxiliaries for lamps. Capacitors for use in tubular fluorescent and other discharge lamp circuits. General and safety requirements
BS EN 61049	Specification for capacitors for use in tubular fluorescent and other discharge lamp circuits. Performance requirements
BS EN 61050	Specification for transformers for tubular discharge lamps having a no-load output voltage exceeding 1000 V (generally called neon-transformers). General and safety requirements
BS EN 61184	Bayonet lampholders
BS EN 61195	Double-capped fluorescent lamps. Safety specifications
BS EN 61199	Single-capped fluorescent lamps. Safety specifications
BS EN 61347-1	Lamp controlgear. General and safety requirements
BS EN 61347-2-1	Lamp controlgear. Particular requirements for starting devices (other than glow starters)
BS EN 61347-2-2	Lamp controlgear. Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps
BS EN 61347-2-3	Lamp control gear. Particular requirements for a.c. and/or d.c. supplied electronic control gear for fluorescent lamps
BS EN 61347-2-7	Lamp controlgear. Particular requirements for battery supplied electronic controlgear for emergency lighting (self-contained)
BS EN 61347-2-8	Lamp controlgear. Particular requirements for ballasts for fluorescent lamps
BS EN 61347-2-9	Lamp controlgear. Particular requirements for electromagnetic controlgear for discharge lamps (excluding fluorescent lamps)
BS EN 61347-2-10	Lamp controlgear. Particular requirements for electronic invertors and convertors for high-frequency operation of cold tubular discharge lamps (neon tubes)
BS EN 61347-2-11	Lamp controlgear. Particular requirements for miscellaneous electronic circuits used with luminaires
BS EN 61347-2-12	Lamp controlgear. Particular requirements for d.c. or a.c. supplied electronic ballasts for discharge lamps (excluding fluorescent lamps)
BS EN 61347-2-13	Lamp controlgear. Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules
BS EN 61535	Installation couplers intended for permanent connection in fixed installations
BS EN 61547	Equipment for general lighting purposes. EMC immunity requirements

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BS EN 61558-1	Safety of power transformers, power supplies, reactors and similar products. General requirements and tests
BS EN 61558-2-1	Safety of power transformers, power supplies, reactors and similar products. Particular requirements and tests for separating transformers and power supplies incorporating separating transformers for general applications
BS EN 61558-2-6	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V. Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers
BS EN 62031	LED modules for general lighting. Safety specifications
BS EN 62035	Discharge lamps (excluding fluorescent lamps). Safety specifications
BS EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
BS EN 62384	DC or AC supplied electronic control gear for LED modules. Performance requirements
BS EN IEC 62386-207	Digital addressable lighting interface. Particular requirements for control gear. LED modules (device type 6)
BS EN IEC 62442-3	Energy performance of lamp controlgear. Controlgear for tungsten-halogen lamps and LED light sources. Method of measurement to determine the efficiency of controlgear
BS EN 62471	Photobiological safety of lamps and lamp systems
BS EN 62504	General lighting. Light emitting diode (LED) products and related equipment. Terms and definitions
BS EN 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50V. Safety specifications
BS EN 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50V. Performance requirements
BS EN 62707-1	LED-binning. General requirements and white colour grid
BS EN 62717	LED modules for general lighting. Performance requirements.
BS EN 62722-1	Luminaire performance. General requirements
BS EN 62722-2-1	Luminaire performance. Particular requirements for LED luminaires
BS EN 62776	Double-capped LED lamps designed to retrofit linear fluorescent lamps. Safety specifications.
BS EN ISO 7010	Graphical symbols. Safety colours and safety signs. Registered safety signs.
BS EN ISO 9241	Ergonomics of human-system interaction
BS ISO 3864-1	Graphical symbols. Safety colours and safety signs. Design principles for safety signs and safety markings
ICEL 1001	Scheme of product and authenticated photometric data registration for emergency lighting luminaires and conversion modules
ICEL 1004	The requirements for the re-engineering of luminaires for emergency lighting use
IEC 62717	LED Modules for general lighting. Performance Requirements
IESNA LM-79-08	Approved Method: Electrical and Photometric Measurement of Solid-State Lighting Products

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IESNA LM-80-15 Approved Method: Measuring Luminous Flux and Colour Maintenance of LED Packages, Arrays and Modules

IESNA TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources

200 PRODUCTS AND MATERIALS

210 Luminaires

211 General

Ensure that all luminaires comply with all relevant British Standards.

Ensure that all luminaires are suitable for the location and environment in which they are to be installed.

Supply, erect, and connect all luminaires complete with all associated components including glassware, diffusers, lamps, appropriate control-gear and gasket seals, in the positions shown on the drawings and/or described in sections V21, V40, V41 and V42 of this specification.

Supply operating manuals, maintenance instructions and parts manuals for all luminaires. Ensure that these documents provide maintenance and care data including periodic and preventative maintenance procedures and intervals, expected lifetime, diagnostic procedures and complete ordering information and sources for all parts provided.

Fit luminaires with cover glass to protect against ultra-violet emissions and risk of explosion from lamps where appropriate.

Provide, where appropriate, secondary support for translucent covers, diffusers and gear trays to prevent them from falling when the primary fixing is released.

Ensure that, for each luminaire type supplied, the manufacturer confirms that their published photometric performance data is within the tolerances defined by BS EN 13032.

Provide only luminaires that comply with BS EN 61547 for EMC immunity.

Ensure that luminaires have sufficient physical protection to satisfy BS EN 60529 and BS EN 62262.

Where luminaires are supported directly from the ceiling T-bar grid, ensure adequate additional fixings are provided by the ceiling installer to support the entire weight of every such luminaire and its attachments, without causing any distortion to the ceiling line or level. In addition, provide a direct single fixing from the body of every such luminaire to the structure, using galvanised steel chain and hook backplates.

Ensure that ceiling- and wall-mounted luminaires, where installed to plasterboard surfaces, are fixed via conduit boxes installed flush with the ceiling/wall face, with the conduit boxes supported directly from the conduit/trunking system or structure.

Liaise as necessary with the luminaire and ceiling tile manufacturer, together with the ceiling installer, to ensure compatibility between the luminaire and the ceiling systems for proper installation.

Ensure all recessed luminaires maintain the ceiling fire barrier rating and integrity of the respective fire compartment or area. Provide proprietary fire rated canopies for recessed luminaires where necessary.

Ensure luminaires specified with thermoplastic diffusers comply with Category TP(a), as defined in the Building Regulations. Provide copies of manufacturer's test certificates to verify compliance.

Ensure that all suspended luminaires utilise proprietary 'cable drop' accessories for final connection.

Ensure that all flexible cords are effectively secured at each termination point by the use of proprietary cord anchors on the outer sheath.

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Ensure that every luminaire is accurately aligned, to fit flush and square against adjacent/abutting structures or surfaces, to provide a neat straight and true appearance in their relation to the building structure.

Set out the lighting system installation in accordance with the co-ordinated reflected ceiling plan drawings and the Architect's detailed room loaded layout drawings. Check the positions of all windows, door swings, roof lights and fitments etc., before commencing the installation of the lighting system.

Ensure luminaires fully comply with the following:

- ~ manufactured to meet the requirements of BS EN 60598
- ~ manufactured to provide Class 1 protection against electric shock
- ~ protected to an ingress class, as referred to in BS EN 60598, of IP 20 minimum
- ~ suitable for operation at 230V, 50Hz, SP&N
- ~ manufactured to meet the requirements of the appropriate electromagnetic compatibility (EMC) Directive of the European Council and appropriately CE marked

Supply all luminaires complete with a fused terminal block to BS 1363.

Ensure all low voltage tungsten halogen or LED luminaires are each provided with an individual 230/12V transformer/driver as appropriate. Secure every such transformer/driver to the building structure; do not allow them to rest on false ceilings.

Provide all luminaires with high frequency (HF) control gear unless stated otherwise on the drawings or in this specification.

Do not permit luminaires that are fixed to, or recessed into, suspended ceilings, to have their weight borne by the ceiling unless written acceptance is obtained from the Contract Administrator.

Suspend luminaires from the structure or from false ceiling support beams using steel strapping, circular steel suspension, or proprietary fixing methods. Use at least two fixings for luminaires up to 300 mm wide and four fixings for sizes over 300 mm wide.

Supply and fix all materials for fixing and suspending the luminaires, from the building structure, building fabric, or system of beams provided by others for the support of false ceilings and/or other services or equipment, unless specified otherwise.

Ensure that the luminaire backplate fully covers the conduit box in concealed installations. Use white break joint rings where the conduit boxes cannot be concealed by the luminaire backplate.

Do not use luminaires for through-wiring unless the luminaire is specifically designed for that purpose and incorporates a segregated wiring channel.

Ensure there is suitable strain relief via clamping of the supply wiring's sheath or strain relief lugs, for every luminaire.

Ensure that the lighting and lighting control system does not undermine the sound pressure levels set by the acoustic brief, the architectural specification, and the project design criteria. Additionally, ensure that the sound power levels associated with any luminaire or luminaire control device located within areas other than equipment spaces, are not of a magnitude such that they cause any noise perceptible against the ambient conditions. Ensure no lighting or lighting control device emits a sound power level of greater than 10dB below the room sound pressure level stated in the design criteria.

Ensure that all luminaires are individually power factor corrected. Use shunt connected capacitors to achieve a power factor greater than 0.95 for fluorescent luminaires, and greater than 0.85 for other discharge luminaires. Ensure LED luminaires' power factor (including both driver and light source) is greater than 0.9.

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Before installing any luminaire ensure that it is appropriately selected for all aspects including: the type of installation, the location in which it is installed, the ceiling void size, the ceiling type (including tee section size) and the lamp voltage.

Provide an assembly of luminaire and exhaust air device or luminaire and supply air device to meet the design requirements for illumination and air flow. Ensure that every such assembly can be integrated and flush-mounted into the associated false ceiling. Ensure that the fixing is capable of carrying the weight of the whole assembly.

Where specified, incorporate a path for exhaust air in the diffuser. Provide an outlet for the air either by a series of circular openings in the top of the assembly or by a circular spigot for direct connection to extract or exhaust ducting.

Ensure that the acrylic diffusers are 100 percent virgin acrylic plastic and have a high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation. The lens thickness to be a minimum of 3mm

Ensure that the glass diffusers are annealed crystal glass unless otherwise indicated.

Ensure that the aluminium diffusers or reflectors consist of high quality aluminium with shape surface finish that is in accordance with the photometric data published for the luminaire.

212 Emergency lighting luminaires

Ensure that all emergency lighting luminaires comply with BS EN 60598, BS EN ISO 7010 and BS ISO 3864-1.

Comply with ICEL 1001. Ensure that emergency lighting luminaires are marked with the ICEL certification labels.

Ensure that luminaires comply with ICEL 1004.

213 Exit signs

Ensure that exit signs comply with BS EN ISO 7010 and BS ISO 3864-1.

214 Hazardous area luminaires

Comply with the following standards:

- ~ BS EN 60079
- ~ BS EN 60598

215 Signs and high voltage installations

Ensure that signs and high voltage installations comply with BS 559 and BS EN 50107-1.

Ensure that neon transformers comply with BS EN 61050.

220 Lampholders

221 General

Comply with the following standards:

- ~ lamp caps - BS EN 60061-1
- ~ lamp holders - BS EN 60061-2
- ~ lamp holders with enhanced safety features – BS 7895
- ~ bayonet lampholders – BS EN 61184
- ~ lampholders for tubular fluorescent lamps and starter holders – BS EN 60400

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~ Edison screw lampholders – BS EN 60238

Ensure that lampholders in luminaires of similar type and rating are identical.

Ensure that metal lampholders incorporate an earthing terminal.

222 Tungsten and equivalent fittings

Provide a shade carrier ring for separately mounted lampholders for GLS tungsten filament lamps.

Ensure that the phase conductor is connected to the centre contact of Edison screw lampholders.

223 Mounting

Securely mount the lampholder in the luminaire when it is the sole support for the lamp.

Provide integral cord grips when lampholders are suspended by cord.

When mounted directly to conduit systems use a backplate lampholder for the conduit box.

230 Control-gear and components

Ensure that control-gear and components are suitable for the lamp type, wattage and starting characteristics.

Ensure that the selected control-gear has a current in-rush characteristic that both singularly and cumulatively with others, does not exceed 80% of the withstand capability of the least rated device in the circuit.

231 Fluorescent lamp ballasts and starters

Ensure that electronic control gear is used wherever possible.

Ensure that fluorescent lamp ballasts and starters comply with the following standards:

Ballasts:

~ BS EN 61347

~ BS EN 60921

~ BS EN 60929 for fluorescent lamps to BS EN 60081 and BS EN 60901

~ BS EN 60730-2-3 for ballasts for tubular fluorescent lamps

Starters:

~ BS EN 61347

~ BS EN 60927

Use low distortion ballast lumen factor 0-15 or greater.

232 Discharge lamp ballasts and starters

Ensure that discharge lamp ballasts and starters comply with the following standards:

~ BS EN 61347

~ BS EN 60923 for ballasts

~ BS EN 60927 for starters

233 Capacitors

Use capacitors in accordance with BS EN 61048 and BS EN 61049 in tubular fluorescent, high pressure mercury and low pressure sodium vapour discharge lamp circuits.

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234 Supply terminals

Use screw terminals for supply cables and circuit protective conductors, each sized to terminate up to three 2.5mm² conductors. Provide separate terminal blocks for each incoming circuit, with marking to identify each circuit.

235 Fuse

Include a fuse holder and BS 1362 fuse in each incoming circuit phase connection.

236 Interference

Comply with BS EN 55015.

237 Remote gear

Locate controlgear in a separate enclosure with the same degree of protection and finish as that specified for the luminaire. Comply with the luminaire manufacturer's recommendations for maximum cable length between gear and lamp.

240 Lamps

241 Tungsten filament and equivalent lamps

Ensure that tungsten filament lamps comply with BS EN 60064, BS EN 60432-1 and BS EN 60630.

Supply electronic step-down converters for filament lamps to BS EN 61347 and BS EN 61047.

242 Fluorescent lamps

Ensure that fluorescent lamps comply with the following standards:

- ~ BS 1853-2 for UK tubular lamps
- ~ BS EN 60901 and BS EN 61199 for single capped lamps
- ~ BS EN 60081 and BS EN 61195 for double capped lamps
- ~ BS EN 60969 and BS EN 60968 for self-ballasted lamps

243 Tungsten halogen lamps

Ensure that tungsten halogen lamps comply with BS EN 60357 and BS EN 60432-2.

244 High pressure mercury vapour lamps

Ensure that high pressure mercury vapour lamps comply with BS EN 60188 and BS EN 62035.

245 Metal halide lamps

Ensure that metal halide lamps comply with BS EN 62035.

246 High pressure sodium vapour lamps

Ensure that high pressure sodium vapour lamps comply with BS EN 62035.

247 Low pressure sodium vapour lamps

Ensure that low pressure sodium vapour lamps comply with BS EN 60192.

248 Transformers for low voltage (LV) luminaires

Ensure that transformers comply with the following standards:

- ~ BS EN 55014
- ~ BS EN 61547
- ~ BS EN 61347

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~ BS EN 61047

~ BS EN 61558

Ensure that transformers are each housed in a sheet steel casing with a demountable lid. Ensure that each such unit has a primary anti-surge fuse and secondary fuse, and that each output to the luminaire is fused. Fit a thermal cut-out that has an automatic reset.

Ensure that all such transformers have soft-start characteristics (0.5 to 1.0 second ramp-up, run-in silent operation), and have an automatically regulated secondary voltage.

Locate transformers in well ventilated areas that are easily accessible.

Where dimming transformers are used, obtain the luminaire manufacturer's written assurance that the transformer is compatible with the luminaire.

249 Lamp manufacturer

Ensure that lamps of the same type are obtained from the same manufacturer.

250 Support systems

251 Conduit

Use conduit of the same type as that used for the lighting system, and diameter no less than 20mm.

252 Rod

Use continuously threaded rods made from bright zinc-plated steel with matching washers and nuts.

253 Chain

Use bright zinc-plated steel chain with load-carrying capacity of not less than twice the weight of the complete luminaire.

254 Flexible cord

Ensure that the temperature rating of the flexible cord is suitable for the operating temperature of the luminaire or lampholder. Ensure that every such cord is adequate for the mass that it supports.

255 Wall bracket

Ensure that every wall bracket is suitable for supporting the associated luminaire.

256 Ball and socket

Provide ball and socket as the top support, complete with cover fixed to a circular conduit box.

257 Columns and bollards

Ensure that columns and bollards comply with BS EN 40.

260 Accessories

261 Lighting track

Where indicated on the drawings or in the schedules, or in section V21 or V42 of this specification, provide track for fixing luminaires in accordance with BS EN 60570.

262 Integral photo-cell

Incorporate an integral photo-cell on each luminaire where indicated on the drawings or in the schedules.

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MANCHETSER ROYAL INFIRMARY

Y73 LUMINAIRES AND LAMPS

270 Light emitting diodes (LED)

271 LED luminaires

Ensure that LED luminaires comply with the general and safety requirements of BS EN 62031.

Ensure that the LED luminaire product data is presented in accordance with BS EN 62722-2-1.

Ensure that the complete LED luminaire is tested in accordance with IESNA LM-79-08 and absolute photometry is conducted in accordance with this method.

Ensure the lumen output of the luminaire complies with the requirements indicated in the luminaire schedule and the luminaire performance is rated for the ambient temperature in which it will operate.

Ensure the maintained luminous flux at 25% of lumen maintenance life up to a maximum of 6000 hours is greater than 90% of the initial lumen output.

Ensure the drive current and junction operating temperatures are in accordance with the LED manufacturer's requirements.

Ensure cooling is achieved by passive heat sinks integral to the luminaire. Do not utilise luminaires with active cooling.

For standard white light applications ensure colour variance is within a 3-step MacAdam ellipse initially and also within a 3-step MacAdam ellipse through lumen maintenance.

For wall-washers, museum lighting and other white light applications where visual appearance is critical, as specified in the luminaire schedule, ensure colour variance is within a 2-step MacAdam ellipse initially and within a 3-step MacAdam ellipse through lumen maintenance.

Ensure luminaires are CE and ENEC marked.

272 LED modules

Ensure that LED modules comply with the general and safety requirements of BS EN 62031.

Ensure that the LED module product data is presented in accordance with IEC 62717.

Ensure that the lumen maintenance of the LEDs within the luminaire is tested in accordance with IESNA LM-80-15.

Meet or exceed the lumen maintenance life specified in the luminaire schedule, ensuring that the declared lumen maintenance life of the LED package, array or module is extrapolated in accordance with IESNA TM-21-11.

Ensure that the minimum performance of the LED module complies with the following

Minimum luminaire efficacy	90 lumens/watt
Minimum colour rendering index(CRI)	65
Minimum LLD at 100 000 hours at 25°C	0.85

273 LED lamps

Ensure that self-ballasted LED lamps with voltage >50V comply with:

- ~ Safety requirements of BS EN 62560
- ~ Performance requirements of BS EN 62612
- ~ The most recent generation of LED models available

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Y73 LUMINAIRES AND LAMPS

274 Electronic control gear for LED modules

Ensure that DC or AC supplied electronic control gear for LED Modules complies with the performance requirements of BS EN 62384.

Ensure that the minimum performance of the control gear complies with the following

Total harmonic distortion	<20%
Power factor	>0.9
Operating temperature range	-40°C to +40°C for all electrical components in the luminaire including the LED engines/modules, drivers and surge devices
Voltage fluctuations	+/- 10%
Dimming control	Integrated capability when specified using an external 0 - 10V DC control signal
Operating lifetime	At least L80 of 50,000 hours
Efficiency	>80%

300 WORKMANSHIP

310 General

Install luminaires complete and as indicated on the drawings or in the schedules. Unless otherwise stated, install luminaires plumb, square, and level with ceilings and walls, and in alignment with adjacent lighting fixtures.

Do not use the permanent lighting installation for temporary lighting purposes during the contract period unless prior written acceptance is obtained from the Contract Administrator. Where such acceptance is given, and the luminaires are not LED, provide new lamps at the handover for the employer's use.

Fix every surface-mounted luminaire to a conduit box (or boxes) that has a porcelain screw type connector.

Fix all luminaires and pendants with brass roundhead screws.

Provide all pendant luminaires with a suspension system and an associated flexible cable to a minimum length of 600 mm unless otherwise defined in section V21, V40, V41 or V42 of this specification.

Connect all metalwork on luminaires to the circuit protective conductor with proper and approved earthing arrangements for metalwork.

Upon completion of the installation and after circuits have been energised, apply power and demonstrate to the Contract Administrator the capability and compliance with requirements of all luminaires and circuits. Correct, or remove and replace, malfunctioning units, then re-test and demonstrate to the Contract Administrator's satisfaction. Ensure that all lamps are fully operational; replace all failed lamps at no extra cost to the contract. When directed by the Contract Administrator, remove all temporary protective covering from luminaires.

320 Orientation

Install luminaires in the positions indicated on the drawings and in the horizontal plane, unless shown otherwise on the drawings or in the schedules.

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Y73 LUMINAIRES AND LAMPS

330 Cleanliness

Ensure that all luminaires are clean and grease-free on handover. Thoroughly clean all luminaires after installation, leaving the installation in a new, clean condition at handover.

340 Installation

341 Recessed fittings

Mount fully recessed luminaires within the suspended ceiling in the positions indicated on the drawings.

Install luminaires flush with the finished surface of the associated ceiling, wall or floor into which they are fitted.

Ensure the luminaire has the correct void, as specified by the manufacturer, for the dissipation of heat. Ensure the luminaire is free of thermal insulation in all directions to a minimum distance of 100mm.

Ensure that all recessed luminaires maintain the fire barrier integrity of their respective area.

342 Semi-recessed fittings

Install luminaires in accordance with the manufacturer's instructions to achieve the extent of recessing required.

343 Wall-mounted fittings

Install luminaires at the height indicated on the drawings or in the schedules.

344 Material supportive surface

Ensure that the fire classification of luminaires is appropriate. Do not mount luminaires on flammable surfaces.

345 Potentially explosive atmospheres

Ensure that the installation complies with BS EN 60079.

346 Areas with infra-red control systems

Install luminaires in areas with infra-red control systems or data bearers, so as not to cause a loss of service, and so as to cause minimum disturbance to the infra-red transmission system in accordance with BS 7693.

347 Signs and high voltage discharge lighting

Comply with BS 559 and BS EN 50107-1.

348 Extra-low voltage tungsten halogen lamps

Use the same wattage lamp on all luminaires fed from a common transformer. Supply each such luminaire on a common transformer, by a separate cable of the same cross-sectional area.

350 Supports

Ensure that every support is adequate for the weight of the associated luminaire.

Provide the following minimum number of supports for each luminaire longer than 600mm:

Luminaire Width (mm)	Minimum number of supports
≤ 300	2
> 300	4

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MANCHETSER ROYAL INFIRMARY

Y73 LUMINAIRES AND LAMPS

351 Conduit

Where luminaires are supported from conduit, provide a conduit box forming an integral part of the lighting conduit system at each point of suspension. Ensure that all such suspensions are vertical. Use tube of the same corrosion resistance as the conduit of the lighting system.

Secure the luminaire body with back-nuts and washers where the conduit enters it.

Where the temperature of the material may exceed 60°C or the mass suspended exceeds 5 kg, do not support luminaires directly from conduit boxes made from non-metallic or heat sensitive materials.

352 Trunking

Where luminaires are supported from trunking, use proprietary clamps or brackets that are compatible with both the luminaire and the trunking.

Where the temperature of the material may exceed 60°C or the mass suspended exceeds 5 kg, do not support luminaires directly from trunking made from non-metallic or heat sensitive materials.

353 Direct fixing

Install luminaires in accordance with the manufacturer's instructions.

354 Luminaires located in suspended ceilings

Support luminaires directly from building fabric and in accordance with the manufacturer's instructions.

Ensure that the type of fixing is suitable for the luminaire weight and ceiling system and complies with the requirements of the luminaire manufacturer.

355 Suspension

Suspend luminaires at the height indicated on the drawings or in the schedules. Ensure that all suspensions hang vertically unless otherwise indicated.

356 Rod

Use washers, nut and lock-nut at the top and bottom of the rod. Paint cut ends with zinc-rich paint.

357 Chain

Use a 'hook cover' for suspension from a circular conduit box. For connection to luminaires use the luminaire manufacturer's own chain hook but, if not available, use a hook with standard screw threaded end and secure it to the luminaire body with nuts and washers. Where indicated use captive hooks.

358 Flexible cord

Suspend cord from the ceiling rose. Ensure strain relief, via the clamping of the cord sheath, is provided at both ends.

359 Ball and socket

Install cable through ball and socket connected to the conduit box.

3510 Columns and bollards

Confirm locations with the Contract Administrator before excavation.

Mount columns or bollards on a base as recommended by the manufacturer.

Ensure columns and bollards are vertical unless otherwise indicated on the drawings or in the schedules, or in section V21, V40 or V41 of this specification.

Install a circuit protective conductor to connect the luminaire to the earthing terminal in the service compartment. Make the circuit protective conductor the same size as the live conductors. Bond the accessible metal parts of the column or bollard to the earthing terminal.

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Y73 LUMINAIRES AND LAMPS

360 Connections

361 Luminaires

Use the appropriate size of grommet where cables enter through the hole in the luminaire body.

Ensure that the earthing terminal of BS EN 60598 - Class 1 luminaires is connected to the circuit protective conductor of the supply circuit.

Clip, or tie back with suitable proprietary devices, loose wiring within luminaires, at 300 mm intervals.

362 Direct to conduit

Terminate circuit wiring in a terminal block within the supporting conduit box. Use flexible cord from the terminal block to the luminaire.

Terminate circuit wiring at the supply terminals of the luminaire. Take all conductors through the same cable entry into the luminaire.

363 Direct to trunking

Terminate circuit wiring in a terminal block in an adaptable box located on the side of the trunking. Use flexible cord from the terminal block to the luminaire.

Terminate circuit wiring at the supply terminals of the luminaire. Take all conductors through the same cable entry into the luminaire.

364 Suspended from trunking

Where luminaires are suspended from trunking, secure plug-in type ceiling rose to BS 6972 and BS 5733 adjacent to, or on the side of, trunking. Terminate circuit wiring at the socket of the ceiling rose. Take flexible cord from the plug of the ceiling rose to the supply terminals of the luminaire.

365 Recessed fittings

Where luminaires are recessed in a suspended ceiling, terminate the circuit wiring at a pluggable installation connector to BS EN 61535, located not more than 500 mm from the access through the ceiling. Use flexible cord complete with corresponding pluggable installation connector to supply the terminals of the luminaire.

Ensure suitable access is provided to the pluggable installation connector either by having suitable access into the void, or providing the facility to withdraw the connector.

Where luminaires are recessed in a suspended ceiling, terminate circuit wiring in a terminal block within the conduit box.

366 MICC cables

Fix a cable gland to each luminaire and continue conductors to the supply terminals of the luminaire.

END OF SECTION Y73

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Y74 ACCESSORIES FOR ELECTRICAL SYSTEMS

Y74 ACCESSORIES FOR ELECTRICAL SYSTEMS

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Y74 ACCESSORIES FOR ELECTRICAL SYSTEMS

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and normative references) of each of the following, current at the time of tender.

Where a Standard referred to in this section conflicts with a Standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the Standard referred to in the engineering system section prevails.

BS 88-3	Low-voltage fuses Part 3: Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household or similar applications). Examples of standardized systems of fuses A to F
BS 546	Specification. Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors
BS 646	Specification. Cartridge fuse-links (rated up to 5 amperes) for a.c. and d.c. service
BS 1361	Specification for cartridge fuses for a.c. circuits in domestic and similar premises
BS 1362	Specification for general purpose fuse links for domestic and similar purposes (primarily for use in plugs)
BS 1363-1	13 A plugs, socket-outlets, adaptors and connection units. Specification for rewirable and non-rewirable 13 A fused plugs
BS 1363-2	13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A switched and unswitched socket-outlets.
BS 1363-4	13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A fused connection units switched and unswitched
BS 2950	Specification. Cartridge fuse-links for telecommunication and light electrical apparatus
BS 4177	Specification for cooker control units
BS 4573	Specification for 2-pin reversible plugs and shaver socket-outlets
BS 4662	Boxes for flush mounting of electrical accessories. Requirements and test methods and dimensions
BS 5733	Specification for general requirements for electrical accessories
BS 6396	Electrical systems in office furniture and educational furniture. Specification
BS 6500	Electric cables. Flexible cords rated up to 300/350 V, for use with appliances and equipment intended for domestic, office and similar environments
BS 6991	Specification for 6/10 A two-pole weather-resistant couplers for household, commercial and light industrial equipment
BS 7071	Specification for portable residual current devices
BS 7288	Specification for socket outlets incorporating residual current devices (S.R.C.D.s)

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BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS 7895	Specification for bayonet lampholders with enhanced safety
BS 8300	Design of buildings and their approaches to meet the needs of disabled people
BS EN 55014-1	Electromagnetic compatibility. Requirements for household appliances, electric tools and similar apparatus Part 1: Emission. Product family standard
BS EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
BS EN 60269	Low voltage fuses (also known as BS 88-1)
BS EN 60309-1	Plugs, socket-outlets and couplers for industrial purposes Part 1: General requirements.
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories
BS EN 60320	Appliance couplers for household and similar general purposes
BS EN 60529	Specification for degrees of protection provided by enclosures (IP code)
BS EN 60598-1	Luminaires. General requirements
BS EN 60598-2	Luminaires. Particular requirements.
BS EN 60669-1	Switches for household and similar fixed-electrical installations Part 1: General requirements
BS EN 60670-22	Boxes and enclosures for electrical accessories for household and similar fixed electrical installations Part 22: Particular requirements for connecting boxes and enclosures
BS EN 60730-2	Specification for automatic electrical controls for household and similar use Part 2: Particular requirements
BS EN 60947	Low-voltage switchgear and control gear
BS EN 61058	Switches for appliances
BS EN 61009	Residual current circuit breakers with integrated overcurrent protection for household and similar uses (RCBO's)
BS EN 61184	Bayonet lampholders
BS EN 61558	Safety of power transformers, power supply units and similar devices

Building Regulations Approved Document Part M – Access to and use of buildings

200 LIGHTING SWITCHES

Ensure local lighting switches comply with the manufacture, rating and type as indicated in the Particular Specification or on the drawings.

Ensure lighting switches comply with the relevant BS.

Ensure switches are capable of switching the full rated inductive or resistive load, and where connected to fluorescent loads in excess of 600 Watts, use minimum 15 amp rating.

Install all switches with suitable boxes of 37 mm minimum depth with adjustable lugs to ensure switch plates are true and square where required. Fit boxes flush with wall finish and make any adjustment to

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depth using extension rings. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Ensure all switch boxes are compatible with the wiring system used and are complete with CPC terminal.

Where several switches of the same phase are required in the same position, use a multi-gang switch box to accommodate all switches on a common faceplate.

Where switches are specified for installation in situations exposed to weather or continual dampness, ensure they are of the weatherproof pattern in accordance with the relevant BS and minimum IP56 rating.

Where different phases are present at one switch location, segregate each phase in a separate compartment and cover each compartment by its own internal warning plate suitably engraved, "WARNING 400 VOLTS PRESENT".

Mount switches adjacent to the closing side of doors where possible.

300 SOCKET OUTLETS

Ensure socket outlets comply with the relevant BS, are switched and shuttered, are mounted in single-gang or multi-gang assemblies, and are of the type and rating as indicated in the Particular Specification or on the drawings.

Fit plug tops to appliances with fuses of the correct rating.

Install all socket outlets with suitable boxes of not less than 35 mm depth with adjustable lugs to ensure socket plates are true and square. Where required fit boxes flush with finished surface (eg floors, skirtings or walls) and make any adjustments to depth using extension rings. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Ensure all socket outlet boxes are compatible with the wiring system used and are complete with CPC terminal.

Ensure all socket outlets installed within circuits likely to serve equipment having high protective conductor currents are provided with dual earth terminals compliant with the high integrity earthing requirements of BS 7671. The dual earth terminal requirement equally relates to any non-socket outlet accessories connected to the same circuit.

Ensure cover plate finishes match the lighting switches and are flush or surface to suit the mounting box.

Ensure the earth terminal(s) of each socket is connected to the box earth terminal with a green/yellow insulated protective conductor. Do not use cover screws for earth continuity.

Ensure socket outlets are complete with indicating lamps where intended for appliances with a heating element.

Where socket outlets are specified for installation in situations exposed to weather or continual dampness, ensure they are of the weatherproof pattern in accordance with the relevant BS and minimum IP56 rating.

400 FUSED CONNECTION UNITS

Ensure these are to the relevant BS and are double-pole switched or unswitched insulated patterns with plates to match the socket outlets.

Where used as a flex outlet for an appliance, ensure they are of the flex outlet pattern with cable anchoring clamp.

Fit fuses of the correct rating.

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Install fused connection units with suitable boxes of not less than 35 mm depth with adjustable lugs to ensure the connection unit are true and square. Fit boxes flush with the wall finish and make any adjustment to depth using extension rings. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Ensure all boxes are compatible with the wiring system used and are complete with CPC terminal.

Ensure all connection units installed within circuits serving equipment likely to introduce high protective conductor currents are provided with dual earth terminals compliant with the high integrity earthing requirements of BS 7671.

Ensure the earth terminal(s) of each connection unit is connected to the box earth terminal with a green/yellow insulated protective conductor. Do not use cover screws for earth continuity.

500 LAMPHOLDERS

Provide ceramic interiors for screw type lamps and when used in areas exposed to weather or continual dampness.

Provide brass lamp holders with ceramic interiors when integral with luminaires.

Provide lamp holders with compression cord grip with integral moulded grip.

Ensure that a suitable suspension method is provided with the lamp holder so that lamps or luminaires are not supported by the cable/termination point and cables are not under stress.

Ensure batten lamp holders are heat resistant and skirted.

Ensure metal lamp holders are effectively earthed using an earth terminal fixed to the lamp holder by the manufacturer.

Ensure low energy lamp holders have a non-standard interface.

Ensure all bayonet lamp holders are safety type unless specified otherwise.

600 CEILING ROSES

Provide ceiling roses for all lighting points with a luminaire suspended by a flexible cable without an integral mounting.

Ensure ceiling roses conform to the relevant BS, of the white insulated pattern incorporating 2, 3 or 4 terminals as necessary, and complete with cord grips.

700 LAMPS

Ensure all lamps are new at handover, allowing reasonable time for testing etc.

"Break-in" fluorescent lamps used on dimming circuits for at least forty hours.

Ensure lamps comply with the relevant BS.

800 FLEXIBLE CABLES

Use flexible cables for pendant luminaires and for final connections to equipment (fixed, or portable). Ensure these are 300/500 V grade to BS 6500, Table II, PVC insulated white circular with high conductivity tinned copper conductors of minimum size 1.0 mm².

Ensure the maximum mass of any suspended luminaire is 5 kg unless additional support is provided.

Use heat resistant flexible cables for all non-pendant type luminaires.

Use heat resistant flexible cables for making final connections to equipment (fixed or portable) with a heating element or equipment fixed to pipework or appliance forming part of a heat distribution system. Ensure the flexible cables are 300/500 V grade complying with the relevant BS.

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Y74 ACCESSORIES FOR ELECTRICAL SYSTEMS

900 CONTROL SWITCHES

Ensure double-pole and triple-pole and neutral control switches are in accordance with relevant BS (Category AC22) respectively and are suited as other accessories defined in the Particular Specification.

Ensure each switch is of the surface or flush pattern as appropriate and install with suitable back box and flylead. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Ensure switch plates are complete with pilot lamp, and where defined in the Particular Specification, engraved with coloured lettering identifying the equipment being controlled.

If cable outlet plates are required for final connections to equipment, suite these to other accessories.

1000 SHAVER SOCKETS

Install shaver sockets in accordance with BS 7671, fed from a local lighting circuit, and ensure they are manufactured in accordance with BS EN 61558.

Ensure mounting back boxes are installed flush with the wall surface in concealed installations. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

1100 COOKER CONTROL UNITS

Ensure cooker control units are manufactured to the relevant BS, and are complete with a suitably rated double-pole switch and where indicated a 13 A switched socket outlet, both with indicating lamp, and suitable back box. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Mount the cooker control unit alongside the cooker, not directly behind or above.

Affect final connections via a fixed cooker connection unit mounted directly behind the cooker. Where split level hobs and ovens are to be provided, see the Particular Specification for the required final connection details.

1200 FUSED CLOCK CONNECTORS

Install fused clock connectors for all mains voltage clock points. Ensure connectors are specifically designed for clock connections and are of the fused plug and socket type, complete with appropriately sized flexible cable for final connections.

Connect clock connectors to the 'local' lighting circuit feed unless otherwise stated on the drawings or in the Particular Specification.

Install all clock connectors with boxes of suitable depth with adjustable lugs to ensure outlet plates are true and square. Fit boxes flush with wall finish and make any adjustments to depth using extension rings. Install back boxes constructed from pressed steel/PVC/pressed steel and PVC as detailed in the Particular Specification.

Ensure all boxes are compatible with the wiring system used and are complete with CPC terminal.

1300 MOUNTING HEIGHTS AND VISUAL CONTRAST

Ensure all accessories are mounted in line with current best practice and at heights to meet accessibility requirements. Refer to Specification Section Y89 for further details.

Ensure that the contrast, as measured by the Light Reflectance Value (LRV), between all accessories and the background they are mounted on meet the Approved Document M requirement to contrast visually.

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END OF SECTION Y74

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MANCHETSER ROYAL INFIRMARY

Y80 EARTHING AND BONDING COMPONENTS

Y80 EARTHING AND BONDING COMPONENTS

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Y80 EARTHING AND BONDING COMPONENTS

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, W51 etc) of this specification, the standard referred to in the engineering system section prevails.

The Electricity Safety, Quality and Continuity Regulations

BS 951	Electrical earthing. Clamps for earthing and bonding purposes. Specification
BS 4444	Guide to electrical earth monitoring and protective conductor proving
BS 5958	Code of practice for control of undesirable static electricity
BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for Electrical Installations. IET Wiring Regulations
BS EN 13599	Copper and copper alloys. Copper plate, sheet and strip for electrical purposes
BS EN 13601	Copper and copper alloys. Copper rod, bar and wire for general electrical purposes
BS EN 13636	Cathodic protection of buried metallic tanks and related piping
BS EN 15112	External cathodic protection of well casing
BS EN 61140	Protection against electric shock. Common aspects for installation and equipment.
BS EN 62305	Protection against lightning
ENA TS 41-42	Guidelines for the design, installation, testing and maintenance of main earthing systems in substations

200 GENERAL

Comply with section W51 of this specification.

Bond the lightning protection system, if fitted, to the main electrical electricity earthing terminal in accordance with section W52 of this specification.

Install the whole of the earthing and bonding installations in accordance with the requirements of BS 7671, the Distribution Network Operator, BS 7430, and other relevant British Standards and Codes of Practice.

Ensure all enclosures, equipment, exposed conductive parts, extraneous conductive parts, metallic trunking, metallic conduits, metallic cable trays and any other metalwork, other than any live part, forming protection or part of the electrical installation, including apparatus and appliances, are effectively bonded to earth and do not form part of the earth fault path of the protective conductor system.

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Y80 EARTHING AND BONDING COMPONENTS

Ensure all main water pipes, main gas pipes, other service pipes, ventilation ducting (including ductwork flexible connections, riser of central heating and air conditioning systems), oil pipe services, storage tank, piped gas systems, etc, and the exposed metallic parts of the building structure are effectively connected to the main earthing terminal points. Make connections using, where applicable, earthing clamps which conform to BS 951.

Fix copper tape to the building structure by means of purpose-made 'spacer bar' saddles.

Ensure bolts, nuts and washers for any fixing of the earth tape are bronze.

300 PRODUCTS AND MATERIALS

310 Earth rods and plates

Earth is normally the earth terminals or earthed cable sheath of the electricity supply installation, provided the company has given written approval for the use of their earthing system for this purpose. Forward duplicate copies of the Distribution Network Operator's written approval to the Contract Administrator before the earth connection is made.

Install an earth electrode system to meet the site and soil condition.

Use solid drawn high-conductivity copper rods to BS EN 13601, 15 mm diameter and 1200 mm sections with internal screw and socket joints.

Use earth plates only where use of earth rods is unsuitable. Make earth plates of solid copper a minimum of 3.0 mm thickness.

Fit rod sections with hardened steel tips and driving caps. Ensure that the depth of the driver rods are a minimum of 2400 mm and the spacing between rods is at least equal to their length. Ensure that no electrode is within 3000 mm of the building foundations.

Make connections by using proprietary clamps and within a concrete inspection pit with removable covers inscribed "EARTH".

Provide earthing terminals at all main incoming supply positions and connect to earth. Ensure main and/or sub-main panels have an earthing terminal and are effectively connected to earth.

Carry out soil resistivity and other tests, as detailed in the relevant British Standard.

320 Extension and alterations to existing installations

Check existing installations which are being extended to ensure that the existing protective conductors comply with BS 7671.

Where a connection is made to another protective conductor, supply and fix a permanent label to BS 7671 and BS 951 indelibly marked with the words "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE".

330 Warning notices

Permanently fix in a visible position a durable label to BS 951 with the words "SAFETY ELECTRICAL CONNECTION – DO NOT REMOVE" at or near:

- ~ the point of connection of every earthing conductor to an earth electrode
- ~ the point of connection of every bonding conductor to an extraneous conductive part
- ~ the main earthing terminal, where separate from the main switchgear

END OF SECTION Y80

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Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (e.g. S10, T31, V21, etc.) of this specification, the standard referred to in the engineering system section prevails.

BS 4444	Guide to electrical earth monitoring and protective conductor proving
BS 4737	Intruder alarm systems (complete series)
BS 5000-3	Rotating electrical machines of particular types or for particular applications. Generators to be driven by reciprocating internal combustion engines. Requirements for resistance to vibration
BS 5000-11	Specification for rotating electrical machines of particular types or for particular applications. Small-power electric motors and generators
BS 5266-1	Emergency lighting. Code of practice for the emergency lighting of premises
BS 5306-0	Fire protection installations and equipment on premises. Guide for selection, use and application of fixed firefighting systems and other types of fire equipment
BS 5611	Application guide for on-load tap-changers
BS 5839	Fire detection and fire alarm systems for buildings (full series)
BS 6266	Fire protection for electronic equipment installations. Code of practice
BS 7430	Code of practice for protective earthing of electrical installations
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS 8243	Installation and configuration of intruder and hold up alarm systems designed to generate confirmed alarm conditions. Code of practice.
BS 8434	Methods of test for assessment of the fire integrity of electric cables
BS 8591	Remote centres receiving signals from alarm systems. Code of practice
BS EN 54	Fire detection and fire alarm systems (full series)
BS EN 1838	Lighting applications. Emergency lighting
BS EN 50147-1	Anechoic chambers. Shield attenuation measurement
BS EN 50171	Central power supply systems
BS EN 50518	Monitoring and Alarm Receiving Centre (full series)
BS EN 55011	Industrial, scientific and medical equipment. Radio-frequency disturbance characteristics Limits and methods of measurement
BS EN 55016-2	Specification for radio disturbance and immunity measuring apparatus and methods. Methods of measurement of disturbances and immunity. Measurement of disturbance power

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BS EN 60034	Rotating electrical machines (full series)
BS EN 60060	High-voltage test techniques (full series)
BS EN 60076-1	Power transformers. General
BS EN 60076-2	Power transformers. Temperature rise for liquid-immersed transformers
BS EN 60076-3	Power transformers. Insulation levels, dielectric tests and external clearances in air
BS EN 60076-5	Power transformers. Ability to withstand short-circuit
BS EN 60076-10	Power transformers. Determination of sound levels
BS EN 61439	Low-voltage switchgear and controlgear assemblies (full series)
BS EN 60849	Sound systems for emergency purposes
BS EN 60896	Stationary lead-acid batteries (full series)
BS EN 60947	Low-voltage switchgear and control gear (full series)
BS EN 61180	High-voltage test techniques for low-voltage equipment. Definitions, test and procedure requirements, test equipment
BS EN 61439-1	Low-voltage switchgear and controlgear assemblies. General rules
BS EN 61439-2	Low-voltage switchgear and controlgear assemblies. Power switchgear and control assemblies
BS EN 61439-3	Low-voltage switchgear and controlgear assemblies. Distribution boards intended to be operated by ordinary persons. (DBO)
BS EN 61557	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. (full series)
BS EN 62040-3	Uninterruptible power systems (UPS). Method of specifying the performance and test requirements
BS EN 62271-1	High-voltage switchgear and controlgear. Common specifications for alternating current switchgear and controlgear
BS EN 62271-200	AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
BS EN 62271-202	High-voltage switchgear and control gear. High voltage/low voltage prefabricated substation
BS EN 62305	Protection against lightning. Risk management
BS EN 62676	Video surveillance systems for use in security applications. (full series)
BS EN ISO 2178	Non-magnetic coatings on magnetic substrates. Measurement of coating thickness. Magnetic method.
BS EN ISO 2409	Paints and varnishes – Cross cut test
BS EN ISO 10012	Measurement management systems. Requirements for measurement process and measuring equipment
BS ISO 8528-6	Reciprocating internal combustion engine driven alternating current generating sets. Test methods
CIBSE Commissioning Code L: <i>Lighting</i> (SLL Commissioning Code L)EN50499	Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

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HTM 05-02	Firecode – Guidance in support of functional provisions (fire safety in the design of healthcare premises) HTM 05-03 Fire safety in the NHS. Operational provisions. (All parts)
HTM 06-01	Electrical services supply and distribution
HTM 06-02	Electrical safety guidance for low voltage systems
HTM 06-03	Electrical safety guidance for high voltage systems
HTM 07-02	Making energy work in healthcare. (All parts)
HTM 07-05	The treatment recovery, recycling and safe disposal of waste electrical electronic equipment (Wales)
HTM 08-02	Lifts
HTM 08-03	Bedhead services
HTM 2005	Building management systems
PSDB 14-95	Home Office - Performance testing of CCTV perimeter surveillance systems
PSDB 9-01	Home Office - Guidance notes for the procurement of CCTV for public safety at football grounds
IET	Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings
IET	Practical considerations for d.c. installations
Association of Manufacturers and suppliers of Power Systems and ancillary equipment (AMPS) standard test procedures	
All data protection legislation including the General Data Protection Regulations	

200 GENERAL (APPLICABLE TO ALL TESTING AND COMMISSIONING PROCEDURES)

Carry out inspection and tests to comply with any British or International standards as necessary on all equipment and installations.

Comply with all aspects of section A32 (Management of the works) of this specification.

Where a substation, HV/LV transformer, HV switchgear, LV switchgear, generator, UPS system or Motor Control Centre(s) have been completely assembled at a manufacturer's works, arrange for the employer's representative to inspect and witness tests on the completed equipment at the works. Give the employer and Contract Administrator at least 14 days' notice of the tests so that they can attend if they wish.

For on-site testing give the employer and the Contract Administrator at least 7 days' notice of the tests so that they can attend if they wish.

Whether or not this opportunity is accepted by the employer provide the complete set of test results and inspection reports to the Contract Administrator after the tests have been completed and before the equipment is installed.

Retest on site any such item of equipment that has been partially dismantled for transportation, unless otherwise agreed with the Contract Administrator.

Prepare and submit a fully detailed programme and method statement for the testing, commissioning and demonstration of each system stating exactly how these are to be carried out and whether they interface with other systems. Ensure the programme includes a schedule of tests to be applied to the system to demonstrate that the fault diagnostic routines function as required. Submit the programme

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and statement to the Contract Administrator for comment one month in advance of the test. Notify manufacturers or specialists of the dates as appropriate.

Arrange for the attendance of a tester to carry out all required tests. Ensure that this tester is not the same person who carried out the installation, unless agreed with the Contract Administrator.

Supply all test instruments. Ensure they are calibrated immediately prior to commencement of testing and operated by trained personnel. Arrange for all calibration certificates to be available for inspection at the time of the tests. Prior to commencement of tests ensure the Contract Administrator is asked to comment on the suitability of the proposed test equipment and methods of testing being adopted.

Provide all specialist equipment, to test and demonstrate the various systems as required.

Arrange and carry out disconnection or similar operations to satisfy the requirements for testing, etc, and the reinstatement of the installation after tests.

Carry out the test procedures in the following clauses in addition to any tests required by the particular system section, or any other 'Y' section, of this specification, as a minimum.

Provide certificates for all testing and commissioning carried out. Include all recorded test results in the operating and maintenance manuals as a record of commissioning prior to contract completion.

Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded, added to the Record Drawings and included within the operating and maintenance manuals.

Provide two days of training (either pre- or post-contract completion, as directed by the Contract Administrator), for nominated client's / end-user's representatives in all aspects of the installation operation that are the user's responsibility.

300 PARTICULAR TEST PROCEDURES

Carry out the following procedures as necessary in accordance with the relevant British or other standards and, if appropriate, the relevant Health Technical Memoranda (HTM).

Ensure that the work's test engineer controls all tests undertaken at the manufacturer's works.

Ensure that, in the presence of the employer's representative, all tests undertaken at site are controlled by the installer/manufacturer.

310 Substations

Test and inspect substation components at the manufacturer's works, whether the substation is packaged or made up of discrete elements.

320 Transformers

Test and inspect power transformers fully in accordance with BS EN 60076-1.

Carry out the following routine tests for all transformers:

- ~ Measurement of winding resistance;
- ~ Measurement of voltage ratio and check of phase displacement;
- ~ Measurement of short-circuit impedance and load loss;
- ~ Measurement of no-load loss and current;
- ~ Dielectric routine tests. (BS EN 60076-3);
- ~ Tests on on-load tap-changers, where appropriate. (BS 5611);

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- ~ Leak testing with pressure for liquid-immersed transformers (tightness test);
- ~ Tightness tests and pressure tests for tanks for gas-filled transformers (BS EN 60076-15);
- ~ Check of the ratio and polarity of built-in current transformers;
- ~ Check of core and frame insulation for liquid immersed transformers with core or frame insulation;
- ~ Test and confirm measurement of the zero-phase sequence.

Carry out the following additional routine tests for transformers with $U_m > 72.5$ kV:

- ~ Determination of capacitances windings-to-earth and between windings;
- ~ Measurement of DC insulation resistance between each winding to earth and between windings;
- ~ Measurement of dissipation factor ($\tan \delta$) of the insulation system capacitances;
- ~ Measurement of dissolved gases in dielectric liquid from each separate oil compartment except diverter switch compartment;
- ~ Measurement of no-load loss and current at 90% and 110% of rated voltage.

Where specified carry out the following tests:

Type tests

- ~ Temperature-rise type test (BS EN 60076-2);
- ~ Dielectric type tests (BS EN 60076-3);
- ~ Determination of sound level (BS EN 60076-10) for each method of cooling for which a guaranteed sound level is specified;
- ~ Measurement of the power taken by the fan and liquid pump motors;
- ~ Measurement of no-load loss and current at 90% and 110% of rated voltage.

Special tests

- ~ Dielectric special tests (BS EN 60076-3);
- ~ Winding hot-spot temperature-rise measurements;
- ~ Determination of capacitances windings-to-earth, and between windings;
- ~ Measurement of dissipation factor ($\tan \delta$) of the insulation system capacitances;
- ~ Determination of transient voltage transfer characteristics (Annex B of BS EN 60076-3:2000);
- ~ Measurement of zero-sequence impedance(s) on three-phase transformers;
- ~ Short-circuit withstand test (BS EN 60076-5);
- ~ Measurement of DC insulation resistance each winding to earth and between windings;
- ~ Vacuum deflection test on liquid immersed transformers;
- ~ Pressure deflection test on liquid immersed transformers;
- ~ Vacuum tightness test on site on liquid immersed transformers;
- ~ Measurement of frequency response (frequency response analysis or FRA). Agree the test procedure between manufacturer and purchaser;

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- ~ Check of external coating (ISO 2178 and ISO 2409 or as specified);
- ~ Measurement of dissolved gases in dielectric liquid;
- ~ Mechanical test or assessment of tank for suitability for transport (to customer specification);
- ~ Determination of weight with transformer arranged for transport. For transformers, up to 1.6 MVA by measurement. For larger transformers by measurement or calculation as agreed between manufacturer and purchaser.

Test and demonstrate that the transformer insulation can withstand a test voltage of the magnitude stated in BS EN 60076-3. Use a combination of the following tests depending on the requirements of table 1 in the standard and the type of winding in the transformer:

- ~ lightning impulse test;
- ~ switching impulse test;
- ~ long duration ac test;
- ~ short duration ac test;
- ~ separate source ac test.

Test and demonstrate that the temperature rises of the active part of the transformer (oil, windings, core), do not exceed the limits agreed on or by the standards.

On every transformer test every Buchholz relay that has been installed.

Test every temperature sensor that has been installed in the oil or embedded in the windings or core, and verify its correct operation, be it alarm or shut-down.

330 Switchgear

331 HV switchgear

Test and inspect all HV switchgear fully in accordance with BS EN 62271-1.

Carry out the following routine tests for all HV switchgear:

- ~ Visual inspection;
- ~ Verification of conformity to the circuit and wiring diagrams;
- ~ Functional tests of all low voltage circuits;
- ~ Verification of protection against electric shock;
- ~ Measurement of the resistance of the main circuit;
- ~ Dielectric test on the main circuit;
- ~ Gas tightness test (if applicable);
- ~ Partial discharge measurement (if applicable).

Ensure that all switchgear has been ASTA type tested and has their approval and certification.

Where switchgear is reassembled on site, retest the switchgear and control gear in line with the standard.

Carry out the following on-site tests:

- ~ Inspect all equipment. Check that it is installed complete according to the installation drawings and this specification, and that it is clean and free from damage. Check that all notices and labelling are correct.

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- ~ Check all connections are correct and tightly fastened.
- ~ Test cabling, switchboard and switchgear insulation at voltages to be agreed with equipment manufacturers and the Contract Administrator in accordance with BS EN 62271-200.
- ~ Check the operation of all switchgear, including trip testing using injection current testing where appropriate.

Adjust and test the HV/LV electrical supply protection relays as required by the protection co-ordination study referred to in section V11 of this specification.

332 LV switchgear

Inspect and test the switchgear assembly fully in accordance with BS EN 61439, and in particular BS EN 61439-1 to comply with type testing or partial type testing.

Ensure that all switchgear and the assembly has been type tested, approved and certified by a UKAS accredited test facility and provide a letter of conformity with the relevant test certificates.

Ensure that all meters fitted to any switchgear have a valid calibration certificate.

Carry out routine tests for:

- ~ Inspection of the assembly including inspection of wiring;
- ~ Electrical operation test;
- ~ Dielectric test;
- ~ Checking of protective measures and electrical continuity of the protective circuit.

Ensure that the settings of all ACBs and MCCBs are in accordance with the design settings as detailed in the schedules.

Verify the correct functioning of all residual current devices (RCD), and confirm that the surge protection devices (SPDs) and arc fault detection devices (AFDDs) are correctly installed and do not indicate any faults. Ensure the AFDDs are tested using the test button on the device, and the RCD using a RCD tester as part of the testing and commissioning.

During commissioning ensure that all switchgear and distribution boards have been correctly labelled and all distribution board schedules are correct and in place.

333 HV and LV switchgear functional tests

Carry out functional tests on switchgear to verify correct operation of the following, where applicable:

- ~ motorised operation of any switchgear;
- ~ contacts, whether volt-free or not;
- ~ power factor correction including sequencer and contactors;
- ~ G99 isolation testing of both mechanical and electrical interlocks;
- ~ Castell key operation;
- ~ Switch earth position if installed;
- ~ Any other control function on the switchgear.

In carrying out the above tests ensure that interlocks and keys effectively prevent any cross phasing, paralleling or unintended action by the switchgear.

334 Protection tests

Within all switchboards, test every protective relay to ensure it functions correctly.

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Check that the current transformers are correctly installed and connected.

Verify the action of all such relays by secondary injection methods.

Check that the system has been graded and that the correct settings have been set up.

Check that the grading settings have been correctly recorded in test sheets and that these settings are recorded in the operation and maintenance manual.

340 Cables

341 HV cables

Test all installed HV cables as detailed in section V11 of this specification and in accordance with the manufacturer's requirements.

Carry out all pressure tests under a 'permit to test' issued by the Authorised Person. Carry out all such tests in the presence of the Contract Administrator.

On every paper insulated cable carry out the "crackle test" on the impregnated bindings before making each joint, to ensure that they contain no water moisture.

342 LV cables

Test all installed LV cables fully in accordance with BS 7671.

Carry out the insulation, continuity and conductor resistance tests required. Be responsible for the conducting of the tests and the subsequent recording and certification of the results. Ensure that, throughout all such tests, both ends of every cable are monitored by a competent person.

When testing long cables that probably have considerable capacitance, be aware of the dangers of stored energy and the need to earth down, in a controlled manner, all cores after each test.

On every paper insulated cable carry out the "crackle test" on the impregnated bindings before making each joint, to ensure that they contain no water moisture.

For large section circuits consisting of more than one conductor per phase, verify the equality of load current sharing between the parallel conductors.

350 Standby generators

Commission and test the complete emergency generator installation in accordance with BS ISO 8528-6 and as follows:

351 Works tests prior to despatch

Carry out works tests prior to despatch as described in the Association of Manufacturers and Suppliers of Power Systems and Ancillary Equipment (AMPS) standard test procedures to demonstrate compliance with all aspects of the specification.

Carry out load tests at full output power with one hour at 10% overload. Measure fuel and lubricating oil consumption at full load.

352 Commissioning following installation

Check the complete generating set is installed as designed and specified, including all wiring connections.

Test the power and control wiring installation, including the earthing system.

Check the functioning of all switchgear, interlocks and controls.

Check the functioning of all auxiliary equipment. Set fuel pump overloads, measure running currents and fuel flow rates.

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Calibrate all sensors and relays (in co-operation with others where appropriate).

Provide the first fill of fuel oil, lubricating oil and anti-freeze.

Commission, test and demonstrate the complete fuel system.

Install equipment for site tests and demonstrations.

353 Site tests and demonstrations

.1 Prior to paralleling with the local distribution network:

With the generators running off-load, demonstrate automatic starting on loss of mains, manual and automatic synchronising, returning to mains, and automatic operation of the earthing system.

Prove the critical shut-down interlocks and alarms and normal shut-down interlocks and alarms.

With a load bank connected demonstrate that the generators will deliver their full load output for 4 hours followed immediately by 1 hour at 110% of full load.

With the generators at 110% of full load, measure noise levels at 1m and 10m from the exhaust system discharge(s) and all related external louvres.

Following the test at 110% of full load demonstrate that load sharing is satisfactory between 40% and 110% of full load (where relevant).

Demonstrate the automatic fuel replenishment system from the bulk tank including testing level switches in both bulk and daily service tanks.

.2 Paralleling with the local distribution network:

Ensure that the detailed requirements for paralleling with the local distribution network have been provided in accordance with Engineering Recommendations G99 and/or G98, depending on the electrical capacity of the system.

Before connection with the mains ensure the following:

- ~ Agreements with the Distribution Network Operator are in place. (Connection agreement, Adoption agreement / Arrangements for operating the interface between the distribution network / generation equipment).
- ~ Meter operator and meter are in place for exporting to the local distribution network.
- ~ Supplier is in place for purchasing the electricity exported to the local distribution network.

Arrange for the generator vendor to test and commission the generator unit in conjunction with the Distribution Network Operator and the electrical and mechanical plant installers. Carry out the following tests:

.3 Operation of electrical protection devices and compliance with BS 7671

.4 Proving engine safety and emergency shut-down devices

.5 For systems installed up to and including 16A, demonstrate compliance as described within Engineering Recommendations G98.

Generally the interface protection and protection functionality are provided by type-tested equipment with protection settings that have been factory set. Providing the settings are as the type-tested figures, there is no requirement to confirm the protection settings.

.6 For systems installed greater than 16A per phase but less than 50kW (3-phase) / 17kW (1-phase) demonstrate compliance as described within Engineering Recommendations G99.

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Generally (where the Distribution Network Operator has agreed) where the interface protection and protection functionality are provided by type-tested equipment with protection settings that have been factory set, there is no requirement to confirm the protection settings.

Where type-tested generating plant has not been used, test and demonstrate full interface protection and protection functionality on site in accordance with G99.

For systems installed greater than 50kW demonstrate compliance as described within Engineering Recommendations G99

Prove the installation has been installed in accordance with the agreed design with respect to:

- ~ Earthing
- ~ Synchronising
- ~ Voltage control
- ~ Frequency control (where applicable)
- ~ Interface protection
- ~ Control procedures
- ~ Interlocks
- ~ Notices and labels.

Ensure that all protection and control settings have been correctly applied and recorded.

Ensure that all metering current transformers (CTs) and voltage transformers (VTs) are of the correct type and class and are compliant with the appropriate metering code of practice and installed with the correct orientation and connections.

Ensure that the overvoltage tests are satisfactory (HV installations).

Ensure that all operational aspects have been implemented and that an agreed operating procedure is established with the Distribution Network Operator.

With the building sufficiently complete to provide at least 50% of the final loads to be connected in an emergency, including major motor drives and any UPS system fitted, demonstrate the complete generator starting sequence and mains restoration sequence, including one or more generators disconnecting as the load is reduced below 45% of full load.

354 Post commissioning

Ensure that completed commissioning form, with a written record of the protection settings and test results, is submitted to the Distribution Network Operator within 30 days of commissioning.

360 CHP generators

Commission and test the complete CHP system installation in accordance with BS ISO 8528-6 and as follows:

361 Witnessing

Ensure that the CHP vendor provides for witnessing by the Contract Administrator of works inspection and tests of the CHP unit.

362 Works tests prior to despatch

Prior to despatch, carry out works tests as described in the Association of Manufacturers and Suppliers of Power Systems and Ancillary Equipment (AMPS) standard test procedures to demonstrate compliance with all aspects of the specification.

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Include load tests at full output power. Measure fuel (oil / gas) and lubricating oil consumption at full load. Give the employer and Contract Administrator at least 14 days' notice of the works tests so that they can attend if they wish.

363 Commissioning following installation

Check the complete CHP set is installed as designed and specified, including all wiring connections.

Check compliance with G98/G99 as appropriate.

Check the functioning of all switchgear, interlocks and controls.

Check the functioning of all auxiliary equipment.

Check lubricating oil and anti-freeze to the engine.

Check the fuel supply complies with current regulations.

- ~ For gas supplies, check functioning of manual shut-off valve, gas filter, gas meter, gas pressure gauge and low pressure relay. Check the CHP unit is capable of operating at the gas pressure measured at the gas connection point.
- ~ For fuel oil supplies, check functioning of fuel oil system as described in the standby generator section in this specification.

Commission, test and demonstrate the complete fuel system.

Test the power and control wiring installation, including the earthing system.

Calibrate all sensors and relays in co-operation with others where appropriate.

Install equipment for site tests and demonstrations.

364 Site Tests and Demonstrations

.1 Prior to paralleling with the local distribution network:

Electrical

With the CHP running (but not paralleled to the local distribution network) demonstrate automatic starting and stopping on loss of mains, automatic synchronising, returning to mains and automatic operation of the earthing system.

Prove the critical shut-down interlocks and alarms and normal shut-down interlocks and alarms.

Mechanical

Prove the control and monitoring system functioning, including CHP unit and boiler sequencing. Check the compatibility and accuracy of all temperature detectors and other instruments.

Carry out combustion testing including monitoring gas supply, water flow test and temperature monitoring.

Carry out continuously monitored performance checks for one week including CHP thermal and electrical outputs and fuel consumption, CHP unit and boiler operation, and water heating circuit temperatures, and CHP unit overall efficiency.

For gas engines, prove that short depressions of gas pressure less than 3 seconds in duration inhibit the low pressure relay from shutting down the CHP unit.

For oil fuelled engines prove the auto fuel replenishment system from the bulk tank including testing level switches in both bulk and daily service tanks.

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Arrange for all tests to be monitored by the CHP unit vendor's service centre and by the building management system where installed.

With the CHP unit operating at 100% of full load measure noise levels at 1m and 10m from the exhaust system discharge(s) and all related external louvres.

.2 Paralleling with the local distribution network:

Ensure that the detailed requirements for paralleling with the local distribution network have been provided in accordance with Engineering Recommendations G99 and/or G98 depending on the electrical capacity of the system.

Before connection with the mains ensure the following:

- ~ Agreements with the Distribution Network Operator are in place. (Connection agreement, Adoption agreement / Arrangements for operating the interface between the distribution network / generation equipment).
- ~ Meter operator and meter are in place for exporting to the local distribution network.
- ~ Supplier is in place for purchasing the electricity exported to the local distribution network.

Arrange for the CHP vendor to test and commission the CHP unit in conjunction with the Distribution Network Operator and the electrical and mechanical plant installers. Carry out the following tests:

.3 Operation of electrical protection devices and compliance with the BS 7671

.4 Engine safety and emergency shutdown device proving

.5 For systems installed up to and including 16A, demonstrate compliance as described within Engineering Recommendations G98

Generally the interface protection and protection functionality are provided by type-tested equipment with protection settings that have been factory set. Providing the settings are as the type-tested figures, there is no requirement to confirm the protection settings.

.6 For systems installed greater than 16A per phase but less than 50kW (3 phase) / 17kW (1 phase) demonstrate compliance as described within Engineering Recommendations G99

Generally (where the Distribution Network Operator has agreed) where the interface protection and protection functionality are provided by type-tested equipment with protection settings that have been factory set, there is no requirement to confirm the protection settings.

Where type-tested generating plant has not been used, test and demonstrate full interface protection and protection functionality on site in accordance with G99.

.7 For systems installed greater than 50kW demonstrate compliance as described within Engineering Recommendations G99.

Prove the installation has been installed in accordance with the agreed design with respect to:

- ~ Earthing
- ~ Synchronising
- ~ Voltage control
- ~ Frequency control (where applicable)
- ~ Interface protection
- ~ Control procedures
- ~ Interlocks

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~ Notices and labels.

Ensure that all protection and control settings have been correctly applied and recorded.

Ensure that all metering CTs and VTs are of the correct type and class and are compliant with the appropriate metering code of practice.

Ensure that the overvoltage tests are satisfactory (HV installations).

Ensure that all operational aspects have been implemented and that an agreed operating procedure is established with the Distribution Network Operator.

Ensure that the noise and vibration measurements, taken with the equipment operating at full load, is within the specified values.

365 Post commissioning

Check that completed commissioning form, with a written record of the protection settings and test results, is submitted to the Distribution Network Operator within 30 days of commissioning.

Arrange for the CHP unit vendor to help the users to set up their own monitoring system to the Contract Administrator's satisfaction.

370 UPS systems

371 Works tests prior to despatch

For type-tested units carry out routine tests at the manufacturer's works as detailed in BS EN 62040-3 section 6.

For non-type-tested equipment, carry out all tests as detailed in BS EN 62040-3 table 3 'type test' column.

In addition to the above carry out the following tests:

- ~ Light load and functional test;
- ~ Synchronisation test;
- ~ Efficiency tests;
- ~ Inspection of input and output waveforms;
- ~ battery test;
- ~ maintenance bypass test;
- ~ static bypass test.

Include standby generator manufacturers in all UPS tests at the manufacturer's premises as required. Make the generator manufacturer responsible for verifying the UPS system test results and the information issued to them at design stage and confirm that there are no issues on interfacing the generator to the UPS systems.

372 Site tests and demonstrations

Where UPS(s) comprise or are delivered as separate functional units intended for final on-site assembly and wiring, carry out final performance tests on site. The site test procedure generally consists of the manufacturer's commissioning procedure and completion of any routine tests from Table 3 of BS62040-3 – UPS test schedule that were not completed prior to delivery. Test each UPS system under simulated full load conditions on completion of the installation works at site.

Carry out tests for total simulation of mains failure and the automatic operation of the standby generator system, together with the functional operation of all isolators / switches / by-passes and controls.

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Demonstrate fully the UPS systems battery support with a total discharge at the 20 minute and 40-minute battery period, as appropriate, at specified full load condition and demonstrate the recovery time over the specified 12-hour period.

Provide a paper chart recorder for the duration of the system tests at site. The minimum demonstration period required for each of the UPS systems is 5 days on-line operation.

Include the recorded test results in the operating and maintenance manuals as a record of all 'on-line' tests and issue at contract completion.

Complete all tests in the presence of the UPS equipment manufacturer's engineer.

380 Emergency lighting

381 General

Fully test and inspect emergency lighting installations in accordance with this specification and generally as outlined in BS 5266, BS 1838, and BS 7671, after first disconnecting all luminaires to prevent damage to the electronic circuits. Provide measured readings of all tests undertaken.

Carry out full testing and commissioning of the automatic emergency lighting testing and monitoring system where specified as set out in section V40 of this specification.

Carry out adjustments and calibration of all automatic control devices and systems to provide optimum operation.

Make available a suitable operative, familiar with lighting controls, as may be required to assist any specialist equipment supplier/manufacturer throughout the commissioning period.

Ensure that CAD record drawings of the lighting installation and associated controls are completed and available on site to specialist equipment supplier/manufacturers prior to commissioning commencement.

Replace all failed lamps of the installed luminaires during the course of the contract works.

Thoroughly clean all luminaires and ensure they are in a new clean condition at handover.

Fully demonstrate the complete operation of the emergency lighting installation to the satisfaction of the Contract Administrator and client's representative.

Arrange a mutually agreed programme for the above demonstrations with the Contract Administrator, providing at least ten working days' notice.

Prepare a method statement for the tests, detailing how they are to be undertaken.

Submit the programme for comment at least four weeks in advance of commencement of testing.

Arrange for all specialist equipment suppliers/manufacturers to provide a minimum of one full day's instruction of the complete emergency lighting system for the Employer's representative prior to the contract completion date, and ensure that the demonstration also includes the automatic testing and monitoring system where specified.

382 Tests to be conducted prior to commissioning

- .1 A visual inspection of the whole installation covering equipment and cable where accessible, to verify compliance with BS 5266-1, BS EN 1838, BS 7671 and this specification.
- .2 Inspect and test the electrical installation in accordance with BS 7671 and record all results on approved test record sheets

Test conductors and other circuit components prior to them being connected to electronic components in order to avoid damage during the electrical installation test procedures. Test electronic equipment in accordance with the manufacturers' instructions.

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Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

Clearly note on the circuit charts and in operating and maintenance procedures the presence of electronic components with an indication that testing procedures may result in damage.

Where any part of the installation is to be concealed within the building fabric carry out tests to ensure that the installation is satisfactory prior to concealment.

- .3 Upon completion of the works subject the whole installation to the tests detailed and note every defect, correct them and bring to the attention of the Contract Administrator.

In the event of any test indicating failure to comply, repeat that test and any preceding it whose results may have been influenced by the faults indicated, after the fault has been rectified.

383 Tests to be conducted during commissioning

- .1 Carry out the following tests and inspections:
- ~ Test the operation of all luminaires and emergency lighting luminaires accessories and items of equipment and check for proper function.
 - ~ Carry out functional test of all light switches, emergency lighting test switches and control devices.
 - ~ Demonstrate the operation of each self-contained luminaire under simulated mains failure condition to prove the luminaire output for the specified time and that the battery is fully recharged within 24 hours.
 - ~ Under emergency lighting conditions, check adequate illumination is available for safe movement on the escape / open areas and all escape route safety signs / fire-fighting equipment location signs and other safety signs identified from risk assessment are visible with the normal lighting extinguished.
 - ~ Carry out full emergency illuminance test in accordance with Annex B of BS 5266 or submit lighting calculations for the scheme.
 - ~ Carry out full duration test of three hours, including confirmation that adequate illumination is available for safe movement on the escape and open areas at the end of the test.
 - ~ Carry out full functional test of the automatic test system for emergency lighting and confirmation that all inputs / outputs are fully operational.

Submit the completion certificate in Annex F of BS 5266-1 to the Building Control Officer. Where light level calculations by the designer is the chosen compliance route, submit the calculations with the completed certificate.

390 Fire alarm

Arrange for the manufacturer or their representative to test and commission the complete fire alarm system fully in accordance with BS 5839 and this specification.

391 General

Carry out, on completion of the installation works, together with the selected specialist equipment manufacturers, the complete testing, commissioning and demonstration of the system operation as detailed below.

Make available suitable operatives, familiar with the fire detection system, as may be required to assist the manufacturer throughout the commissioning period.

Ensure that CAD record drawings of fire alarm systems are completed and available on site to manufacturers prior to commissioning commencement.

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Ensure that the tests are largely composed of simulated faults that are artificially imposed on the system. Check all visual units, alphanumeric displays, and printers to establish that all programmed messages are displayed correctly. Ensure all control panel switches undergo functional demonstration of correct operation.

Complete and produce the commissioning and test certificate for scrutiny before any part of the project can be handed over and accepted.

Ensure that 'As Fitted' drawings and manuals are available before the demonstration and instructions.

Fully demonstrate the complete operation of the system to the satisfaction of the Contract Administrator and, where appropriate, the Fire Officer.

392 Tests to be conducted prior to commissioning

Prior to commissioning carry out the following tests:

- .1 Carry out a visual inspection of the whole of the installation, including equipment and cabling in subways, walkways, crawl ways, ceilings and floor voids where accessible.
- .2 Check insulation resistance tests cover all circuits forming part of the system and made between phases, phase to neutral, phase to earth and neutral to earth. Ensure that the method of undertaking insulation resistance tests does not adversely affect any sensitive system components, and if required, isolate sensitive devices prior to undertaking the tests.
- .3 Check correct polarity of the alarm devices, bells, sirens, klaxons, etc, and all items where correctness of polarity is essential
- .4 Check the programming of the fire alarm system to ensure all detectors are in the correct zone. Base the zoning arrangement on the arrangement shown on the drawings and/or as required by the British Standard. Allow for making minor adjustments to the zoning arrangement to suit the final position of the fire doors and other zone boundaries. Agree all such adjustments with the Contract Administrator.

393 Tests to be carried out during commissioning

During commissioning carry out testing in accordance with the requirements of BS 5839 and BS EN 54, including, but not limited to, the following:

- .1 Test the operation of all panels, accessories and items of equipment and check for proper function, including such items as may have been supplied by others but wired under the electrical installation. Carry out these tests under normal operating conditions, including the discharge and recharging of the 'battery' system, and record the results.
- .2 Functional test of all manual "break glasses"
- .3 Functional test of all smoke detectors by use of an approved smoke generator testing device
- .4 Functional test of all "fixed temperature" or "rate of rise" heat detectors, by an approved heat source testing device
- .5 Simulated tests for fire or fault alarm at detectors and manual contacts as may be instructed by the Contract Administrator, with all tests agreed and recorded on to a system checklist to be approved prior to any witness testing being carried out.
- .6 Testing of all sprinkler sensors and fusible link units
- .7 Testing of all visual indicators under simulated operational conditions with sounders out of circuit
- .8 Testing of auxiliary signals to remote panels and via BT lines, etc

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- .9 Five simulated faults, at randomly chosen locations on each loop circuit and sounder interface secondary circuit, for each of the following type:
 - .1 open circuit
 - .2 short circuit
 - .3 sensor removal/alarm device removal
 - .4 earth fault
- .10 Simulated charger and battery faults for all power supply units (panels, interface units, etc), followed by a battery discharge test (i.e. 24-hour quiescent detection of the full alarm system, followed by 30 minutes alarm operation)
- .11 Simulated operation of mechanical plant where such faults (if any) are required to operate the fire alarm system (e.g. fire/smoke dampers).

Ensure that during routine fire alarm system testing, certain functions are inhibited, i.e. gas supply shut-off valve, smoke damper operation, etc. Provide suitable key switch facilities.

394 Audibility tests

Carry out, prior to full commissioning of the rest of the system, the following tests:

- .1 Fully test the fire alarm system audible alarm facility to ensure that the correct audibility levels are achieved as required by the relevant standards.
- .2 Carry out tests on completion of the installation when all mechanical plant is fully functioning to ensure that realistic results are obtained, including all normal background noise levels.
- .3 Measure and record the sound pressure level in each room, area or plant space. Carry out and record the number of tests necessary to have results from the highest to lowest background noise conditions in each area to obtain average values.
- .4 Inform the Contract Administrator, in writing, of any areas where the required audibility levels are not achieved.

Arrange for the manufacturer to carry out the audibility tests twice. Carry out the first test on completion of the system when all mechanical plant is fully functioning to ensure that realistic results are obtained. Carry out the second test approximately six months later when the building is operating under normal conditions. Carry out both tests in the presence of the Contract Administrator.

In the event that the required audibility levels are not achieved, provide any additional sounders and wiring required to rectify this, and repeat the audibility tests at no additional cost to the contract.

395 Documentation

- .1 Provide the required fire alarm system test certificate(s), issued by the specialist manufacturer, in the forms as detailed in BS 5839 and other relevant standards.
- .2 Record all audibility test results, present in tabulated form and include in the operating and maintenance manuals.
- .3 Provide a full set of zoning diagrams to depict the exact zoning arrangement as required by the British Standards. Frame, glaze and mount adjacent to the main panel and repeater panel in agreed positions to facilitate clear recognition of alarm condition location.
- .4 Provide full details and include within the tender for the provision of a full 12 months system maintenance contract including system inspection and test as recommended by BS 5839.

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Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

400 PARTICULAR TEST PROCEDURES - CONTINUED

410 Intruder alarm

Arrange for the specialist security Installer to carry out the testing and commissioning of the system as detailed below and in the relevant parts of the specification section W41.

411 Testing

On completion of the installation, undertake full technical and performance tests on the entire system, including, as a minimum, the following tests:

- ~ Check all wiring is correctly terminated and labelled.
- ~ Check all equipment is correctly labelled.
- ~ Confirm the supply voltage is correct at all parts of the system.
- ~ Verify that the system continues to work when the main power supply is disconnected.
- ~ Test the correct operation of all detectors, and the elimination of false alarms.
- ~ Test the correct operation of manually operated devices.
- ~ Test the correct operation of annunciation devices, and measure and record sound levels.
- ~ Test the operation of all software functions.
- ~ Test the operation of remote monitoring and control via the LAN.
- ~ Test the effectiveness of access level settings.
- ~ Test the receipt of all types of alarm signals to the remote monitoring facility.
- ~ Test tamper protection of devices, enclosures, and wiring.

Ensure that the entire system satisfies all test criteria.

Before demonstrating the system, submit to the Contract Administrator full tests results, as well as a certificate of conformity that lists details of all aspects of the system that do not conform to the intended requirements.

412 Commissioning

Demonstrate to the Contract Administrator that the system complies with all technical and functional requirements, of the specification

Demonstrate all functions of the intruder alarm system to the users and the user's insurers, after successful demonstration to the Contract Administrator.

Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded and added to the record drawings and included within the operating and maintenance manuals.

420 Access control

Carry out the testing and commissioning of the system in accordance with the requirements as detailed below, and in section W40 of the specification.

421 Testing

Obtain all permissions and consent as might be necessary to remain compliant with the requirements of the General Data Protection Regulations.

On completion of the installation, undertake full technical and performance tests on the entire system, include as a minimum the following tests:

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- ~ Check all wiring is correctly terminated and labelled.
- ~ Check all equipment is correctly labelled.
- ~ Confirm the supply voltage is correct at all parts of the system.
- ~ Verify that the system continues to work when the main power supply is disconnected.
- ~ Test the correct operation of all devices.
- ~ Test the correct operation of manually operated devices.
- ~ Test the correct operation of annunciation devices, and measure and record sound levels.
- ~ Test the operation of all software functions.
- ~ Test the operation of remote monitoring and control via the LAN.
- ~ Test the effectiveness of access level settings.
- ~ Test tamper protection of devices, enclosures, and wiring.

422 Commissioning

Undertake the following commissioning procedures:

- ~ Test all reader devices and demonstrate that the system meets with the overall operation and control functional requirements detailed.
- ~ Calibrate all field devices.
- ~ Provide a hard copy print-out of the events recorded during the commissioning.
- ~ On completion of the commissioning and testing, provide a certificate of conformity.
- ~ Setup the operator and supervisor security access levels on the integrated system.
- ~ Setup the alarm annunciation on the operator computers and all remote computers.
- ~ Fully demonstrate software graphics.
- ~ Ensure that site plans used by the computer software are current.
- ~ Check release times for each door.
- ~ Check door held open signal.

423 Communication link

Where a remote monitoring centre is used, ensure that the alarm communication link to the remote centre is fully tested and commissioned as follows:

- ~ Check the link before connecting the system.
- ~ Warn the remote centre of the test.
- ~ Initiate the alarm, contact the remote control centre / station and confirm that the alarm condition has been received.
- ~ Confirm the end of testing once the system links have been fully commissioned.

424 Interfaces

Commission every system scheduled below independently and as an integrated, co-ordinated system as detailed within the specification:

- ~ Access control system

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- ~ Surveillance system
- ~ Alarm monitoring system
- ~ Intercom facilities
- ~ Fire alarm system
- ~ BMS
- ~ Vehicle traffic light system
- ~ Lighting control

Commission the access control system under normal power supply conditions, followed by a simulated power failure that proves that the backup UPS supports the system.

Test, prove and commission the interfaces with the following systems under normal and emergency power modes:

- ~ Fire detection and alarm system
- ~ BMS.

Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded and added to the record drawings, and included within the operating and maintenance manuals.

430 Public address

Arrange for the specialist Installer to carry out the testing and commissioning of the system as detailed below, to the standards detailed in section W12 and to BS 7671.

Ensure that commissioning meets the requirements of BS EN 60849 with particular attention to 'RASTI measured intelligibility'.

Liaise with the manufacturers of the interfaced systems to ensure all tests and demonstrations are fully co-ordinated.

Prepare a fully detailed method statement for the test, commissioning and demonstration stating exactly how these are to be carried out including interface with the fire alarm system. Submit the statement to the Contract Administrator for comment one month in advance of the test.

431 Visual examination

Visually examine the installation, including the following:

- ~ Check for segregation to BS 7671.
- ~ Check that all items are correctly and safely installed
- ~ Check that the system is correctly earthed.
- ~ Check continuity of system.
- ~ Check all equipment is operational.

432 Testing

Undertake the following testing and commissioning procedures:

- ~ Test all devices and demonstrate that the system meets the overall operation and control functional requirements detailed.
- ~ Calibrate and set all speaker outputs, microphone units, and amplifier / control units.

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- ~ Calibrate and set all amplifier outputs and adjust volume control as appropriate.
- ~ Carry out a full speech intelligibility test using the Room Acoustic Speech Transmission Index (RASTI) method. Ensure that the emergency voice communication system EVC obtains a minimum of 0.5 in all accessible parts of the installation.
- ~ Carry out a subjective check of the sound output in all areas using a person with normal hearing.
- ~ Carry out a functional test of the complete system to ensure the correct operation of the system to the satisfaction of the Contract Administrator.
- ~ Where applicable carry out a full functionality test of the voice evacuation system (VES) to demonstrate full integration with the fire alarm system (FAS) during FAS operation
- ~ Where applicable commission the voice evacuation system under normal power supply conditions, followed by a simulated power failure that proves that the backup UPS supports the system.

Where applicable, test, prove and commission the interfaces with the following systems under normal and emergency power modes:

- ~ Fire detection and alarm system
- ~ BMS.

Ensure all control arrangements, settings and sequences on completion of commissioning and demonstration are recorded and added to the record drawings, and included within the operating and maintenance manuals.

440 Nurse call

Arrange for the specialist installer to carry out the testing and commissioning of the system as detailed below, in Health Technical Memorandum 08-03, in section W14 of the specification and in BS 7671.

Liaise with the manufacturers of any interfaced systems to ensure all tests and demonstrations are fully co-ordinated.

441 Visual examination

Visually examine the installation, including the following:

- ~ Check for segregation to BS 7671.
- ~ Check that all items are correctly and safely installed
- ~ Check that the system is correctly earthed.
- ~ Check the continuity of the system.
- ~ Check all equipment is operational.

442 Testing

Undertake the following testing and commissioning procedures:

- ~ Test all devices and demonstrate that the system meets the overall operation and control functional requirements detailed within the specification.
- ~ Carry out a functional test of the complete system ensuring the correct operation of all devices.

443 Commissioning

- ~ Demonstrate the complete system to the Contract.

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- ~ Once accepted by the Contract Administrator, demonstrate the complete system to the end user.
- ~ Provide a hard copy print of the events recorded during the commissioning.
- ~ Issue a system verification certificate.

450 Vertical or horizontal busbar systems

Test all busbar systems fully in accordance with BS 7671 and to the requirements specified in section Y62 of this specification.

Carry out the following tests:

- ~ Visual inspection
- ~ Insulation tests
- ~ Earth bonding and continuity tests.

460 Lighting and power installations

For all lighting and power installations, inspect and test the complete installation fully in accordance with BS 7671.

Carry out the inspection and tests in the same sequence as set out in BS 7671, and in such time as to allow any remedial work to be completed within the contract period.

Prior to void-closures, carry out, as a minimum, insulation resistance testing to all mains voltage cabling, and supply the results to the Contract Administrator for comment.

Ensure tests also include any part of an existing installation related to the new work. Carry out the following BS 7671 tests before making the system live:

- ~ Visual inspection, including verifying that:
 - o the cable containment is supported adequately;
 - o all luminaires are complete with lamps and accessories;
 - o lamps are of the correct colour, rating and manufacturer selection;
 - o control devices have been correctly installed;
 - o all switch plates align straight and true;
 - o all required labelling has been provided;
 - o luminaires and lamps are in clean condition;
 - o SPDs are operational;
- ~ Continuity of protective conductors including main and supplementary equipotential bonding;
- ~ Continuity of ring final circuit conductors;
- ~ Insulation resistance, ensuring that devices such as AFDDs and SPDs are not damaged, or cause incorrect results when the test is performed;
- ~ Site applied insulation resistance;
- ~ Verification of protection by separation of circuits;
- ~ Verification of protection against direct contact by barrier or an enclosure provided during erection;

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- ~ Electrical resistance of floors and walls that provide protection against direct contact;
- ~ Polarity;
- ~ Earth electrode resistance;

Carry out the following BS 7671 tests after making the system live:

- ~ Earth fault loop impedance;
- ~ Prospective fault current;
- ~ Functional testing (testing of RCDs, RCBs, AFDDs, interlocks, etc).

Test and commission the lighting system in accordance with CIBSE Commissioning Code L.

Engage the specialist equipment installer/manufacturer to set up, prove the operation and function and fully commission the lighting management system together with its associated control devices.

Set up, prove the operation and function and fully commission all individual control devices including switches, presence detectors, photocell sensors, and contactor/relay units, etc.

Carry out adjustments and calibration of all automatic control devices and systems to demonstrate optimum performance and operation.

Record all control arrangements, settings, sequences and functions on completion of commissioning and demonstrations.

Demonstrate the operation of all control functions to the satisfaction of the Contract Administrator and Employer's representative after commissioning has been fully completed.

Provide out-of-hours attendance, as necessary, during periods of darkness, for the demonstration and verification of operation and function of particular lighting systems.

Make average illuminance measurements of the installed lighting system, as recommended by the CIBSE Code for Lighting, throughout all areas of the building. Incorporate the results on the lighting system 'Record' layout drawings.

Test the installed lighting system progressively during construction and upon final completion of the whole installation. Test the complete lighting system, including luminaires, control devices and all associated equipment in accordance with the manufacturer's recommendations.

Measure the installed cable lengths for underwater lighting circuits and submit a report in writing to the Contract Administrator.

Verify that the control devices for underwater lighting operated correctly.

470 Electromagnetic compatibility Issues

Where section W53 of this specification requires that a specialist be employed to report on electromagnetic compatibility issues, ensure that the specialist carries out an ambient electromagnetic interference (EMI) survey of the areas of the building described in section W53, using an appropriate instrument. Make an inspection to ensure that the specialist's recommendations have been fully implemented before making the electrical system live.

After the electrical system is live but before the protected systems and equipment are operated, arrange for the specialist to carry out EMI tests to confirm that the electric and magnetic field strengths are within the required limits.

Ensure that the EMI survey and tests are carried out in accordance with appropriate standards including BS CISPR 16, BS EN 50147-1 and BS EN 55011.

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Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

480 DC supplies and batteries

Carry out, on any dc supply installed, all relevant tests required by BS 7671. Carry out all tests as recommended by the manufacturer on any rechargeable batteries installed, in compliance with a relevant standard such as BS EN 60896–11 and the

- ~ IET :Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings
- ~ IET: Practical considerations for d.c. installations

490 Street/area/floodlighting

491 Visual inspection

Visually inspect the completed installation to verify that:

- ~ all cable containment is supported adequately;
- ~ all luminaires are complete with lamps and accessories;
- ~ all lamps are of the correct colour, rating and manufacturer selection;
- ~ all control devices have been correctly installed;
- ~ all switch plates align straight and true;
- ~ all required labelling has been provided;
- ~ all luminaires and lamps are in a clean condition;

Carry out a visual appraisal of the completed and energised lighting system in conjunction with the Contract Administrator.

492 Testing

Fully test the lighting system installation in accordance with BS 7671.

Test the installed lighting system progressively during construction and upon final completion of the whole installation.

Test the complete lighting system, including luminaires, control devices and all associated equipment in accordance with the manufacturer's recommendations.

493 Commissioning

Engage the specialist equipment installer / manufacturer to set up, prove the operation and function, and fully commission the lighting control system, together with its associated control devices.

Set up, prove the operation and function and fully commission all individual control devices including switches, presence detectors, photocell sensors and contactor/relay units.

Carry out adjustments and calibration of all automatic control devices and systems to demonstrate optimum performance and operation.

Provide out-of-hours attendance as necessary during periods of darkness, for the demonstration and verification of operation and function of particular lighting systems.

After all street and road lighting has been tested and commissioned operate it for a minimum of 100 hours, then take illuminance readings. Ensure that all such readings are compliant section V41 of this specification.

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Y81 TESTING AND COMMISSIONING OF ELECTRICAL SYSTEMS

After all floodlights have been tested and commissioned operate them for a minimum of 100 hours and then take illuminance readings. Ensure that all such readings are compliant with section V41 of this specification.

500 PARTICULAR TEST PROCEDURES - CONTINUED

510 Studio/auditorium/arena internal lighting

511 Compliance

Inspect, test and commission the system in accordance with CIBSE Commissioning Code L and BS 7671.

512 Visual inspection

Visually inspect the completed installation and verify that:

- ~ the cable containment is supported adequately;
- ~ all luminaires are complete with lamps and accessories and operating as expected;
- ~ lamps are of the correct colour, rating and manufacturer selection;
- ~ luminaires have been positioned correctly;
- ~ control devices have been correctly installed;
- ~ all switch plates align straight and true;
- ~ all required labelling has been provided;
- ~ luminaires and lamps are in a clean condition.

Carry out a visual appraisal of the completed and energised lighting system in conjunction with the Contract Administrator and employer's representative.

513 Testing

Test the installed lighting system progressively during construction and upon final completion of the whole installation.

Test the complete lighting system, including fixed luminaires, control devices and all associated equipment in accordance with the manufacturer's recommendations.

Test the outlets on lighting patch panels to confirm the correct operation, using a test luminaire.

Provide tabulated copies of all test result sheets

514 Commissioning

Set up, prove the operation and function and fully commission all individual control devices including switches, presence detectors, photocell sensors, and contactor/relay units, etc.

Carry out adjustments and calibration of all automatic control devices and systems to demonstrate optimum performance and operation.

Engage the specialist equipment installer/manufacturer to set-up, prove the operation and function and fully commission the lighting management system together with its associated control devices.

Record all control arrangements, settings, sequences and functions on completion of commissioning and demonstrations and include in the operating and maintenance manuals.

Provide all out-of-hours attendance necessary during periods of darkness, for the demonstration and verification of operation and function of particular lighting systems.

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Make average illuminance measurements of the installed lighting system(s), as recommended by the CIBSE *Code for Interior Lighting* and BS 12464, throughout all areas of the building. Incorporate the results on the lighting system record layout drawings.

520 Miscellaneous – motors

521 Motor starters and controllers / motor control centres

Subject the panels, before dispatch, to physical inspection, insulation testing, sequence and component operation testing. Provide certificates recording the works inspections and tests.

Following installation on site, check and provide evidence that all wiring connections are correct.

Check that the functioning of all components and controls is correct, including the correct functioning of all interfaces with associated equipment. Measure power wiring insulation and earth loop impedance and record the results.

Arrange for special units such as variable frequency inverters to be checked and commissioned by their manufacturers, or according to the manufacturers' specific instructions for the units fitted.

Measure and record all motor currents. Set motor overloads to motor nameplate full load currents. Note that star/delta starters normally have overloads installed in the delta loop and set to full load current x 0.58.

Ensure that during commissioning and testing no motor that has reached normal operating temperature is started more frequently than twice in one hour, or according to the motor manufacturer's instructions if different.

Carry out, on any DC supply installed, all relevant tests required by BS 7671 and this specification.

522 Motor drives

Ensure that every belt coupling is accurately aligned and tensioned in accordance with the belt manufacturer's instructions.

Set all starter overloads to the motor nameplate full load current

Where thermistor relay operation is fitted, check it.

With the motor delivering its maximum required duty measure (with suitable true r.m.s. instruments) and record the following:

1. for 3-phase motors - each phase-to-phase voltage (400V nominal); for 1-phase motors – the phase-to-neutral voltage (230V nominal);
2. for 3-phase motors - each phase current; for 1-phase motors – the line current;
3. the motor shaft speed;
4. for belt coupled machines - the driven pulley shaft speed.

530 Earthing and bonding

Where a building is equipped with a lightning protection system, test the system in accordance with this specification, including testing its bonding to other systems, and in accordance section W51 of this specification.

Test that all earthing and bonding is fully in compliance with BS 7671 and BS 7430, and prove all protective conductors are fully in accordance with BS 4444.

Carry out full impedance/continuity testing of all service carriers prior to connecting to the earthing system, to the Contract Administrator's satisfaction.

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On completion of the contract works, carry out all necessary tests to prove the effectiveness of the complete earthing system. Ensure that the earth electrode system achieves an overall resistance as detailed in specification section W51 noting the requirement to provide additional electrodes if the systems fail to meet the specified resistance to earth.

540 Telecommunications

Where external and internal telephone wiring is installed, carry out testing fully in accordance with the telephone service provider's (TSP) specification and section W10 of this specification.

Where internal and site-wide telephone and data wiring form one integral wiring system, test it as detailed in the Data section, clause 550 of this specification section.

Carry out the following tests:

- ~ visual inspection, verifying that:
 - o the cable containment is supported adequately;
 - o control devices have been correctly installed;
 - o all cabling is correctly installed and secured;
 - o all required labelling has been provided;
- ~ continuity of protective conductors including main and supplementary equipotential bonding;
- ~ verification of protection by separation of circuits;
- ~ verification of protection against direct contact by barrier or an enclosure provided during erection.

550 Data

551 General

Thoroughly test the cabling installation to confirm that the components and installation practices meet the defined standards in W30 and any specific client specifications.

552 Testing

553 UTP cable tests

Test all UTP horizontal and riser cables, following installation, for:

- ~ pair polarity;
- ~ crossed pairs;
- ~ continuity;
- ~ short circuits;
- ~ length;
- ~ attenuation;
- ~ cross talk (near and far end);
- ~ PS-NEXT;
- ~ EL FEXT;
- ~ PS-ELFEX;
- ~ propagation delay;

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- ~ delay skew.

Check the results against declared published results for the types of cable used and notify the Contract Administrator of any variations.

Ensure each pair in each link is tested from both ends and the worst pair results used as the test result.

554 Fibre optic cable tests

Test all optical fibre cabling on the reel prior to installation using a light meter.

Do not use cables with any identified faults; remove such cables from site.

Test all fibre optic cables following installation, including the following tests:

- ~ visual check for damage to each terminated connector;
- ~ Optical time-domain reflectometer (OTDR) from both ends;
- ~ attenuation measurement using a light source and power meter;
- ~ front-lit microscope examination at 200X, for each termination connector.

Examine each optical element for the following:

- ~ random mated loss at connectors;
- ~ sudden step in attenuation coefficient or back scatter;
- ~ losses due to excessive bending;
- ~ different lengths recorded at each end of an element.

Record the following test results, for each end of each cable:

- ~ length;
- ~ random mated loss of each mated connected pair (to a resolution of 0.02db or better).

555 Test equipment

Provide a valid calibration certificate that is less than six months old for each item of test equipment brought to site to measure performance data. Make the calibration certificate available for inspection on site.

Ensure UTP test equipment can provide Level II accuracy for both channel and basic link in accordance with requirements of the American National Standards Institute (ANSI) Technical Services Bulletin EIA/TIA TSB67.

Ensure all fibre optic test equipment complies with the appropriate standards.

Ensure the light source and power meter pair provide attenuation accuracy better than 0.02db and operate at 850nm and 1310nm.

Provide microscope(s) for inspection of terminated fibre optic connectors, conforming to the following:

- ~ magnification of 200X minimum;
- ~ allow connection of SC connectors;
- ~ built-in front illumination;
- ~ built-in infra-red blocking filter.

Maintain full records of all testing carried out and the results of the tests, and include in the operating and maintenance manuals.

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560 Radio and television aerial systems

With the system manufacturer, fully test, commission and demonstrate the system in accordance with the manufacturer's recommendations and those of the standards listed in section W20 of this specification, and as detailed below. Liaise with manufacturers of the interfaced systems to ensure all tests and demonstrations are fully co-ordinated.

561 Testing and commissioning

Undertake preliminary checks to ensure that the system and system components are in a satisfactory and safe condition before commencing the commissioning.

On completion of the installation undertake the complete testing, commissioning and demonstration of the system operation in accordance with the British Standards to verify the following.

- ~ correct antenna alignment;
- ~ correct signal strength for all digital TV channels (terrestrial and satellite);
- ~ correct signal strength for all FM channels;
- ~ correct signal strength at every outlet.

562 Commissioning

Undertake operational selective viewing and/or listening tests on all channels provided, at each co-axial socket outlet including any reconnected existing outlets to demonstrate the following:

- ~ that all channels and teletext operate satisfactorily;
- ~ there is no discernible difference in picture, sound or teletext quality of the same receiver, whether connected to the co-axial socket outlets specified or to the aerial input of the head-end equipment, using attenuators if necessary;
- ~ measuring and recording of the signals levels throughout the system at the input and output of each amplifier and at the output of the antenna(s) head-end equipment;
- ~ the operation of the TV sound and volume control at each outlet.

Record all signal dB losses and signal strength throughout the system on completion of the commissioning and demonstration, and include this information on the as-fitted" drawings and within the operating and maintenance manual.

Issue a system test certificate detailing compliance with all the relevant British Standards and this specification.

570 Surveillance system

Arrange for the specialist surveillance system installer to carry out the testing and commissioning of the system as detailed below and in section W42 of the specification. Comply with the requirements of BS EN 50132-1 & NACP 20

571 General

On completion of the installation and working with the specialist equipment manufacturer carry out the complete testing, commissioning and demonstration of the system operation as detailed below.

Ensure that CAD record drawings of the surveillance system are completed and available on site to the manufacturer prior to commissioning commencement.

Return to site one month after Practical Completion to prove the recording archive capacity.

572 Testing

Carry out tests according to the relevant system specification section and the following:

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- ~ Check every video cable for continuity and shorts to earth. Check through every video line to ensure that all terminations are set correctly.
- ~ Check that the correct lens is fitted in line with the specification. Set up the lens focus and back focus of the camera. If automatic iris lenses are fitted, adjust the peak/average and level potentiometers. Check that the field of view is as required.
- ~ Where zoom lenses are fitted, check that the scene remains in focus throughout the zoom range.
- ~ Check the dwell time and sequencing of standard video switchers. In the case of matrix switchers set up the dwell times and sequences for each monitor. If there is a master/slave situation, ensure that the units are correctly located with the master control at the main control location.
- ~ Check that all functions are operating correctly and that end stops are set as required. Make sure that the pan right and tilt down controls correspond to the right direction of movement. If pre-set positions are incorporated, set them up according to the manufacturers' instructions and to the specified fields of view.
- ~ Set the time, date and camera titles. Programme the multiplexer according to the video recorder in use.

For external systems, carry out the main programming at night under the worst lighting conditions.

On completion, undertake full performance tests on the entire system. Ensure that the entire system satisfies all test criteria, and in particular ensure the system conforms to NACP 20 requirements.

Before demonstrating the system, submit to the Contract Administrator full tests results, as well as a certificate of conformity that lists details of all aspects of the system that do not conform to the intended requirements.

573 Commissioning

Obtain all permissions and consent as might be necessary to remain compliant with the requirements of the General Data Protection Regulations.

After testing has been successfully carried out, demonstrate all applicable functions to the Engineer, including but not limited to demonstrating the following:

- ~ All wiring is correctly terminated and labelled;
- ~ Camera and lens are fitted correctly for each position to achieve the desired field of view;
- ~ Effective operation of all cameras in different light levels;
- ~ Correct setting of all pan and tilt limits and associated automatic control;
- ~ Correct supply voltage at all parts of the system;
- ~ Effective operation of supplementary lighting;
- ~ Operation of recording systems under alarm and steady-state conditions;
- ~ Recording and display of the system under all alarm conditions;
- ~ Search and retrieval of all types of recorded surveillance data;
- ~ Operation of all software functions;
- ~ Effective operation of video analysis software;
- ~ Walk tests with any volumetric-device-operated cameras;

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- ~ The system continues to work when the main power supply is disconnected.

Change lenses as required where the required field of view is not achieved.

Capture and record images of the specified targets, and of the Rotakin test described below, on the system, under both normal lighting conditions and under lowest light conditions.

Demonstrate the compliance of the surveillance system to the above requirements by performing a series of tests using a standard Rotakin® target to simulate a “person” as referred to above. Ensure that the resolution of the recorded images as viewed on screen is such that the lines at marking *reference C* on the target can be distinguished when the target occupies 100% of the vertical dimension of the screen at 25 images per second.

Export these images to a protected USB solid state drive.

Demonstrate to the Contract Administrator that the content of the USB drive can be viewed in full resolution and at full frame rate on a standard personal computer operating on a Microsoft Windows operating system, without the need for special software.

Demonstrate to the Contract Administrator that, when the content of the USB drive is viewed through a standard, non-networked personal computer, the images are of such quality that a viewer is able to achieve all of the following:

- ~ **monitor** the movement of a person or persons, when the figure occupies 5% of the vertical dimension of the screen;
- ~ **detect** a person when the figure occupies 10% of the vertical dimension of the screen;
- ~ **recognise** a known person when the figure occupies 50% of the vertical dimension of the screen; and
- ~ **identify** beyond reasonable doubt an unknown person when the figure occupies 120% of the vertical dimension of the screen.

Demonstrate all functions of the surveillance system to the user after successful demonstration to the Contract Administrator.

Test the Surveillance system of sports grounds to demonstrate compliance with the requirements of PSDB 14/95 and appendices B, C & D of PSDB 09-01.

580 Lightning protection and surge protection

Ensure that the complete lightning protection system and surge protection devices are fully tested by the specialist installer all in accordance with BS EN 62305.

Make provision for witnessing of the testing procedure by the Contract Administrator.

With its test link removed and without any bonding to other services, measure the earth resistance of every individual earth electrode. Ensure such resistance in ohms does not exceed ten times the number of down conductors on the structure.

Measure with the test links in place the resistance to earth of the complete lightning protection system at any point on the building. Ensure that all results from this test do not exceed ten ohms. Carry out this test prior to bonding to other services. If the overall resistance exceeds ten ohms provide, at no additional cost to the employer, any means (e.g. the addition of earth mats or plate electrodes) as recommended by BS EN 62305, to reduce the overall resistance.

Fully tabulate all test results and record in the operating and maintenance manuals

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590 Thermal imaging/acoustic vibration testing

In locations where a thermal image survey of cable terminations, busbar field connections and general switchboard components, or an acoustic vibration test, is specified:

- ~ Carry out the survey using a thermal imaging camera capable of producing a hard copy or of producing a digital image that can be viewed on a computer and printed therefrom.
- ~ Arrange for the survey to be carried out by a specialist company or for the camera to be operated by a person specifically trained in its use.
- ~ Carry out an acoustic vibration survey to ascertain the origin of any unusual or unacceptable noise.

600 PARTICULAR TEST PROCEDURES – CONTINUED

610 PHOTOVOLTAIC SYSTEMS TESTING AND COMMISSIONING

611 General

Test and commission the electrical elements of the installation in accordance with BS 7671. Follow the procedure set out in *Photovoltaics in Buildings – Testing, Commissioning and Monitoring Guide* as published by ETSU for the Department for Trade and Industry.

Ensure commissioning of the PV system is carried out by a competent person.

Provide a minimum of 15 days' notification to the DNO for their attendance at ENA Engineering Recommendation G98 and G99 witnessing tests. Provide the DNO with all necessary protection test results as is required under ENA Engineering Recommendation G98 and G99, including those required even in the absence of DNO attendance.

612 Commissioning following installation

Conduct a thorough visual examination of the system to ensure components have not been damaged during installation. Test all AC and DC isolation devices to prove their proper function.

Verify the correct operation of any inverters and associated control and protection systems before the PV system is connected to the grid.

For electrical outputs, up to and including 16 A, comply with the relevant requirements of ENA ER G98.

For electrical outputs, greater than 16 A per phase but less than 50 kW (3 phase) / 17 kW (1 phase), comply with the relevant requirements of ENA ER G99. Provide attendance for witness testing by the DNO (at their discretion).

For electrical outputs installed greater than 50 kW comply with the relevant requirements of ENA ER G99. Provide attendance for witness testing by the DNO for HV connections, and LV connections (at their discretion).

613 Site acceptance tests and demonstrations

Perform a full system site acceptance test after commissioning during hours of daylight. Ensure that final commissioning of the PV system is undertaken with a minimum irradiation level of 600 W/m².

Once the generation system is commissioned, issue a 'G98/G99 Commissioning Confirmation' form and an operation diagram to the DNO within 28 days. Record the results of the testing and commissioning procedures and include within the operating and maintenance instruction manuals.

As part of witnessing, measure solar irradiance and demonstrate that the output of the PV systems equals or exceeds the manufacturer's declared performance for those conditions.

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Demonstrate that the instantaneous efficiency of the installed solar PV system meets that specified using a calibrated reference device to measure incident irradiance falling on the PV system.

Use either a pyranometer, PV reference cell or other solar irradiance tool as the calibrated reference device and allow for any temperature-related compensation effects.

Ensure that the energy generation validation specified in V17 is undertaken and the results documented and included with the test results.

Record the testing and commissioning results and include within the operating and maintenance instruction manuals. Include full details of all protection and other settings of the system within the operating and maintenance instruction manuals.

620 Integrated system test

621 General

Carry out on completion of the installation works and after successful commissioning of all systems, the complete testing, commissioning and demonstration of the integrated systems operation as outlined below. Develop, complete and produce a comprehensive test plan for comment by the Contract Administrator at least two weeks before the test.

Ensure that critical systems included within the integrated system test include all systems interfaced with life-safety systems, including but not limited to:

- ~ Security and access control systems;
- ~ Lift and escalator systems;
- ~ Safety systems;
- ~ Warning systems (eg water leak detection);
- ~ Building management systems;
- ~ Systems provided for safe operation of the development (eg mechanical ventilation to enclosed space or critical equipment);
- ~ Power distribution systems (eg HV and LV distribution, switchgear, automatic transfer switches etc);
- ~ Fire detection and alarm systems;
- ~ Fire suppression systems (eg sprinkler, wet riser).

Incorporate and test the monitoring of all non-critical systems status as part of the integrated system test.

Make available suitable operatives, familiar with all the relevant systems that will be affected, as required to facilitate and assist during testing. Ensure that record drawings of all relevant systems are completed and available on site prior to test commencement. Provide necessary access and communication equipment during the test to all attendees.

Carry out tests comprising simulated faults artificially imposed on the systems. Check all visual units, alphanumeric displays, and printers to establish that all programmed messages are displayed correctly. Carry out functional demonstrations of correct operation of all control panel switches.

Fully demonstrate the complete operation of the systems to the satisfaction of the Contract Administrator and, where appropriate, the Building Control Officer and the Fire Officer.

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622 Activities to be conducted prior to test

Submit and gain approval for a comprehensive cause and effect schedule complete with detailed method statement for the test. Plan for and co-ordinate the test with the required parties, arranging for it to be completed "out of hours".

Carry out a visual inspection of the whole of the installations and obtain confirmation that all life-safety, critical and non-critical systems are fully functional with no errors or alarms prior to starting the test.

Confirm that the test can proceed without risk to people and property and all the necessary notifications have been issued to the affected parties.

623 System test

Complete the approved integrated system test of life-safety systems with all associated interfaced systems. Carry out tests to demonstrate that the operation, interaction and coordination of multiple individual systems perform their intended function, including but not limited to:

- ~ All life-safety and critical systems continue to operate under partial incoming power failure.
- ~ Relevant life-safety systems and critical systems continue to operate under full incoming power failure (eg fire detection and alarm system, access control outstations).
- ~ All life-safety and critical systems return to normal operation when power returns with no intervention.
- ~ Critical communication and network equipment.
- ~ Critical cooling systems.

624 Tests to be carried out

Detail tests to be carried out, including, but not be limited to, the following:

- ~ Incoming site main power failure: systems expected actions and operations;
- ~ Incoming site main power return: systems expected actions and operations;
- ~ Site secondary power failure: systems expected actions and operations;
- ~ Site secondary power return: systems expected actions and operations;
- ~ Incoming site main and secondary power failure: systems expected actions and operations;
- ~ Incoming site main and secondary power return: systems expected actions and operations.

625 Activities to be conducted on completion of the test

Repair or modify any parts of the system that failed any test, to ensure that the reason for the failure will not be repeated.

Repeat the test if deemed to be required by the Contract Administrator, performing all necessary work until the integrated test is completed to the satisfaction of the Contract Administrator with all elements fully functional as expected.

Return all systems to normal operational status and notify the affected parties that the tests are complete.

Complete all the test documentation and issue to the Contract Administrator.

626 Documentation

Document all the tests and results. Describe the sequence of any actions required to return the systems to normal operation.

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Include the test plan, cause and effect schedule, method statements and test results in the operating and maintenance manual.

700 INSTRUMENTATION

Supply all test instruments for the tests required. Ensure that all such instruments are calibrated and supply the current calibration certificate for each. Ensure that all such instruments comply with BS EN ISO 10012.

800 CERTIFICATES AND SCHEDULES

Ensure that all completion certificates, test certificates, schedules and reports required by the relevant BS or International or other standards are recorded and produced before handover of the project. As a minimum, provide the following documents for each system:

- ~ works test certificates;
- ~ certificates for type-tested components;
- ~ site commissioning certificates;
- ~ record drawings;
- ~ warranty certificates for the installation and individual components;
- ~ operating and maintenance instruction manuals;
- ~ records of test results, documented to confirm compliance with the design and/or specification;
- ~ schedule of the contact details of the support and maintenance companies for each of the products.

Include copies of all completion certificates, test certificates, schedules and reports within the operating and maintenance manuals at completion of the project.

END OF SECTION Y81

PROJECT RED ELECTRICAL INFRASTRUCTURE MANCHETSER ROYAL INFIRMARY

Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this Specification, the standard referred to in the engineering system section prevails.

The Health and Safety (Safety Signs and Signals) Regulations

BS 1710	Specification for identification of pipelines and services
BS 3858	Specification for binding and identification sleeves for use on electric cables and wires
BS 4781	Specification for pressure-sensitive adhesive plastics labels for permanent use
BS 4800	Schedule of paint colours for building purposes
BS 4999	General requirements for rotating electrical machines
BS 5070	Engineering diagram drawing practice
BS 5306	Code of practice for fire extinguishing installations and equipment on premises
BS 5472	Specification for low voltage switchgear and controlgear for industrial use. Terminal marking and distinctive number. General rules
BS 5499	Graphical symbols and signs. Safety signs including fire safety signs
BS 6272	Specification for low voltage switchgear and controlgear for industrial use. Terminal marking. Terminals for external associated electronic circuit components and contacts
BS 7671	Requirements for electrical installations. IET Wiring Regulations
BS EN 60073	Basic and safety principles for man-machine interface, marking and identification. Coding principles for indicators and actuators
BS EN 60445	Basic and safety principles for man-machine interface, marking and identification. Identification of equipment terminals, conductor terminations and conductors
BS EN 60447	Basic safety principles for man-machine interface, marking and identification. Actuating principles
BS EN 61082-1	Preparation of documents used in electrotechnology. Rules
BS EN 61439	Low-voltage switchgear and controlgear assemblies
HSE L64	Safety signs and signals. The Health and Safety (Safety Signs and Signals) Regulations 1996. Guidance on Regulations

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HTM 06-01	Health Technical Memorandum 06-01: Electrical services supply and distribution
HTM 06-02	Health Technical Memorandum 06-02: Electrical safety guidance for low voltage systems
HTM 06-03	Health Technical Memorandum 06-03: Electrical safety guidance for high voltage systems

200 GENERAL

Provide all identification labels and notices in accordance with BS 7671.

Install warning, caution and instruction notices where indicated in the engineering system sections of this Specification or on the drawings, or where required, to ensure safe operation and maintenance of electrical systems and of the items to which they connect.

Fix a warning notice in all positions where there are live parts which are not capable of being isolated by a single device. Ensure that warning notices state the location of each isolator. Ensure that every such warning notice is in a prominent position and clearly visible before access to the live parts can be gained.

Ensure that, where a nominal voltage exceeding 230V exists, a warning label stating the maximum voltage is present and clearly visible.

Ensure that all identification labels and notices are installed in a visible position, without interference to the operation and maintenance of equipment.

Ensure that labels and notices are sized in proportion to the equipment on which they are mounted and that they are securely fixed.

Obtain agreement from the Contract Administrator, with regard to style, colour, lettering, size and position of all labels and notices. Provide samples, at no cost to the contract, for the Contract Administrator's acceptance.

Identify every termination and joint box by an externally fitted label indicating the type of service contained, such as 'bells', 'radio', 'fire alarm'.

210 Materials and marking

Ensure that materials used for labels and notices have a predicted lifespan equal to or greater than the lifespan of the installation to which they refer.

Ensure that labels and notices which are fitted outside buildings use the appropriate material and marking method from the following list:

- ~ rigid, laminated, ABS substrate material, of three or five layers of different colours, machine engraved in a contrasting colour [eg Traffolyte]
- ~ rigid plastic, hot press printed
- ~ pressure sensitive labels to BS 4781, printed
- ~ brass, engraved
- ~ stainless steel, engraved

Ensure that labels and notices which are fitted within buildings use the appropriate material and marking method from the following list.

- ~ rigid, laminated, ABS substrate material, of three or five layers of different colours, machine engraved in a contrasting colour [eg Traffolyte]

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- ~ thermosetting rigid plastic, screen printed
- ~ flexible plastic, screen printed or manuscript lettering
- ~ rigid plastic, hot press printed
- ~ pressure sensitive adhesive labels to BS 4781, printed
- ~ aluminium or aluminium alloy, letter pressed, letter engraved or letter embossed
- ~ stainless steel, engraved

220 Fixing

Ensure that fixing methods and materials have a predicted lifespan equal to or greater than the lifespan of the installation to which they are applied.

Fix every label and notice using materials compatible with it and with the surface to which it is being fixed. Use only non-corrodible fixings for external labels and notices.

Thoroughly clean surfaces of dust, loose materials and protective/oily films before fixing labels and notices to them. Fix labels and notices to a surface only after all finishing to that surface is complete.

300 LABELLING OF EQUIPMENT

310 Cables

Provide all cables including those routed underground, on cable trays, on cable ladders or in wire baskets, except final sub circuit wiring enclosed in conduits or trunking, with identification labels.

Fix each underground cable with a label at each point it emerges from or enters the ground.

Identify all cables using a proprietary alphanumeric marker system similar to 'Critchley' manufacture or an accepted equivalent. Provide for the cable reference at both ends of the cable, at either side of wall/ floor/ roof penetrations, and at every fourth floor within the riser and include in the tender for up to fourteen (14) alphanumeric characters. When cable markers with a Limited Fire Hazard (LFH) rating are required, zero halogen markers made from self-extinguishing material shall be provided.

Ensure that all cable identification labels provide a 'unique reference number' to include the following information unless agreed otherwise with Contract Administrator:

- ~ points of termination (ie the locations where the cable starts and finishes)
- ~ size and number of conductors
- ~ type of cable (eg LSZH, XLPE, PVC)
- ~ operating voltage of cable

311 Cable conductor colour coding

Identify cable conductors in accordance with BS 7671; note that a lighting sub-circuit switch wire is a phase conductor in a single phase circuit.

312 Cable sheath identification

Submit for agreement by the Contract Administrator the colour and coding methods of both internal and external cable sheaths.

Ensure that fire alarm cables use red, telephone and data cables use grey, intruder alarm and nurse call cables use white, television aerial cables use brown and speaker cables use black unless otherwise stated in the system sections of this Specification.

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Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

313 Terminal marking and conductor identification

Apply identification markers, in accordance with BS 7671, to all conductor termination points.

Arrange for the manufacturer of switchgear and controlgear to mark their terminals in accordance with BS 5472 and BS 6272. Use a unique reference to identify each element in the switchgear or control gear. Mark the unique reference on or adjacent to each element. Identify each terminal for connection to external wiring or cabling using a reference system complying with BS EN 60445 based on the element reference and the appropriate element terminal reference.

Use lettered or numbered ferrules or sleeves to BS 3858 to mark each core, cable, auxiliary conductor, control cable core or any other conductor not otherwise obviously identifiable. Mark all cores, cable and conductor within all switchgear, controlgear, distribution boards, and all other enclosures with the identity of the terminal to which it is connected and the reference of plant or equipment to which it is connected and the identity of the terminal at the remote end.

Identify the main circuit conductors in accordance with BS 7671.

Ensure that the material of cable markers is at least the same standard, or better, as the cables they identify, ie LSZH.

314 Underground cables

Provide cable route markers in accordance with section Y61 of this Specification, and upon each of them clearly indicate the following information:

- ~ type of cable and date installed
- ~ operating voltage of cable
- ~ depth at which cable is buried

Mark and protect direct buried cables with one of the following:

- ~ concrete cable covers
- ~ clay ware cable covers
- ~ recovered plastic cable tiles
- ~ recovered plastic cable tiles with integral yellow printed black warning tape
- ~ plastic tape yellow printed black

320 Conduit and trunking colour coding

In areas of mechanical plant or voids accommodating mechanical services, or where otherwise indicated in the 'engineering system' sections of this Specification or on the drawings, identify electrical conduits in accordance with BS 1710. Apply colour 'orange' to BS 4800, by one of the following methods:

- ~ painting on service as a band over 150 mm
- ~ applying an adhesive tape (of wrap-around type services) over a length of 150 mm

Place such identification colours at bulkheads, wall penetrations and any other place where identification is necessary.

330 Switchgear

Ensure that all switchgear is fitted with labels in accordance with BS 7671 and BS EN 61439 to indicate duty of unit, its voltage, phase and current rating, protective device rating, size of conductor involved, and all other necessary details.

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Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

Use an agreed serial coding system, and provide at the switch a legend of the coding system.

Identify loose switchgear such as fused switches, switch fuses, distribution boards, isolators, indicating switches, starters and control switches controlling remote equipment, by fitting an external label or engraving, indicating the equipment controlled.

340 Distribution boards

Clearly identify the circuit ways either by the miniature circuit breaker or fuse bases and carriers being indelibly numbered in an accepted manner or by a label. Use a numbered plan or a printed statement held in a pocket on the inside of the door, to the effect that the numbering of the ways is from left to right, or top to bottom.

Internally

Identify every outgoing way with a renewable circuit chart, in a transparent plastic envelope, permanently fitted inside the cover of every distribution board.

Clearly indicate for each circuit, in typed script, the following information:

- ~ circuit identification number
- ~ cable size
- ~ fuse or circuit breaker rating (including whether an RCD or not)
- ~ description of item supplied and area supplied by circuit

Label all cable connections internally with their circuit reference. Use lettered or numbered ferrules or sleeves to BS 3858.

Externally

Clearly identify each distribution board, with a label that is compatible with the schematic and wiring diagrams, and complies with BS 7671.

350 Motor and starter labels

Fit identification labels to all motors, starters and starter panels. Ensure the positive identification of respective motors and starters. Ensure that all such labelling is compatible with schematic and wiring diagrams and complies with BS 4999-103.

Check that every motor bears secure markings indicating the type of lubricant to use (if any) at its bearings and its correct direction of rotation. Where it does not, notify the Contract Administrator.

Check that every motor fitted with surge suppressors or thermistors bears secure markings indicating that insulation test voltages must not be applied. Where it does not, notify the Contract Administrator.

360 Colour corrected luminaires

Fit a warning or identification disc under the lamp(s) of luminaires containing colour corrected fluorescent tubes or other corrected light sources, to remind maintenance staff to install the correct lamps.

370 Plant and equipment labels

Label all electrical plant and equipment with the labels specified in the appropriate British Standards for that plant or equipment.

Fit labels on all items of electrical equipment, switches, etc, that include the following information:

- ~ service controlled
- ~ circuit reference

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MANCHETSER ROYAL INFIRMARY

Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

- ~ voltage and number of phases
- ~ circuit protection type and rating

Label all 'accessory boxes' internally with their circuit reference.

Identify externally the mid-point of each ring main circuit.

Engrave switchplates, spur units, pushes and special plates for bedhead units, call systems, fire alarms, kitchen appliances, etc, as indicated in the 'engineering system' sections of this Specification or on the drawings. Use 6 mm high letters with engraving (in a contrasting colour), except where otherwise stated.

Where voltage above ELV exists, label all electrical plant and associated controlling equipment, using safety signs.

380 Indicator lamps and push buttons

Use indicator lamp and push button colours in accordance with BS EN 60073.

390 Final circuit accessories

Label all electrical final circuit accessories such as socket outlets, fused connection units, cooker outlets, isolators etc., with labels that indicate the circuit reference, unless instructed by the client that the accessories must be not labelled. Label the back boxes when the client has indicated that no label must be placed on the outside surface.

Ensure that, where additional protection by RCD is not provided, socket outlets with a rated current not exceeding 20A and mobile equipment with a current rating not exceeding 32A for use outdoors are provided with a label indicating the particular item of equipment it serves.

Label all 'back boxes' internally with their circuit reference.

Identify externally the mid-point of each ring main circuit.

Use 6 mm high letters with engraving (in a contrasting colour), except where otherwise stated.

Where voltage above ELV exists, label all electrical plant and associated controlling equipment, using safety signs.

400 SIGNS NOTICES AND DIAGRAMS

410 Safety signs

Ensure that all safety signs comply with HSE L64.

Ensure that each safety sign is of the correct type and complies with BS 5499.

Provide with each safety sign supplementary or text signs complying with BS 5499.

Identify each substation and main switchroom with safety signs and supplementary signs complying with BS 5499 and, for any associated fire extinguishing system, with BS 5306. Ensure that all such notices and signs give details of:

- ~ name of the substation or switchroom
- ~ the presence of high and low voltages
- ~ administrative instructions for access
- ~ location and method of contacting controlling authority
- ~ actions to be taken in emergency

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Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

420 Additional safety signs

Provide additional safety signs at locations shown on the drawings or noted in the engineering system sections of this Specification or as appropriate, in accordance with BS 5499. Ensure that all such additional safety signs comply with HSE L64.

430 Maintenance notices

Fix notices giving warning of and instructions on, any special maintenance procedures to plant and equipment to ensure that people are informed before maintenance is carried out. An example is for a standby generator; "Do not isolate the power supply to a sprinkler water pump without first obtaining a 'permit to work'".

Upon completion of the installation or maintenance work, ensure that notices of periodic inspection and testing are fixed in a prominent position at every installation.

440 Schematic diagrams

Permanently fix to a nearby wall of the room, a purpose made schematic diagram, showing all the electrical connections to equipment and plant served at the following locations:

- ~ at main switchgear
- ~ at sub-main switchgear

Ensure that all such diagrams and symbols comply with BS 5070 and BS EN 61082-1.

Ensure schematic is at least A3 drawing size and mounted in picture frame.

450 Earthing

Adjacent to the final connection of the electrical system of the building to the earth electrode or earthing terminal, provide a clear and permanent warning label stating "Safety Electrical Connection – do not remove".

Fit labels describing the purpose and instructions for operation and maintenance to all special purpose earthing conductors [eg 'clean earths' for IT networks] and connection points.

Label main earth bonding cables in the same manner as submain cables.

460 Shock treatment card

Provide a copy of the 'Electrical Times' Shock Treatment Card at each main switch panel position. Ensure that the card gives the following information:

- ~ instructions for isolating a person from live conductors
- ~ artificial respiration and resuscitation methods
- ~ location of the nearest telephone and the telephone number of whom to contact for assistance

470 Periodic inspection and testing notice

Fix a periodic inspection and testing notice in accordance with BS 7671.

480 Alternative supplies

Fix warning notice for all alternative or multiple supplies in accordance with BS 7671.

490 Non-standard colours

Fix warning notices to BS 7671 where the installation contains wiring colours under different versions of BS 7671.

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Y82 IDENTIFICATION OF ELECTRICAL SYSTEMS

END OF SECTION Y82

PROJECT RED ELECTRICAL INFRASTRUCTURE MANCHETSER ROYAL INFIRMARY

Y89 SUNDRY COMMON ELECTRICAL ITEMS

Y89 SUNDRY COMMON ELECTRICAL ITEMS

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Y89 SUNDRY COMMON ELECTRICAL ITEMS

100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and normative references) of each of the following, current at the time of tender. Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (eg S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

Building Regulations	Approved Document M: Access to and use of buildings Approved Document B: Fire Safety
Disability Discrimination Act	
BS 5839	Fire detection and fire alarm systems for buildings
BS 5266	Emergency lighting
BS 7671	Requirements for electrical installations. IET Wiring regulations
BS 8300	Design of buildings and their approaches to meet the needs of disabled people
BS EN 61537	Cable management. Cable tray systems and cable ladder systems
BS IEC 60050	International Electrotechnical Vocabulary
CAE & RIBA	Designing for Accessibility

200 GENERAL

210 Definitions

Use the definitions given in BS 7671. Where a term is not defined in BS 7671, use that given in BS IEC 60050.

220 Electricity supply

Ensure that the electricity supply provided is at 400/230V, 50Hz, 3-phase, 4-wire, unless detailed otherwise in the 'engineering system' sections of this specification. Check that the fault level at the origin, and the earth-loop impedance external to the installation, is as given in the 'engineering system' sections of this specification and inform the Contract Administrator if they are not. Ensure that the size and rating of the overcurrent device at the origin, and the method of earthing used in the installation, is as given in the 'engineering system' sections of this specification or as indicated on the drawings.

230 Design criteria

The main distribution schematic diagram and/or the 'engineering system' sections of this specification, indicates the design criteria applicable at the time of tender.

Do not make any change to the installation that invalidates such design criteria without prior written agreement from the Contract Administrator.

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Y89 SUNDRY COMMON ELECTRICAL ITEMS

300 PRODUCTS AND MATERIALS

310 Faulty materials and workmanship

Replace any material or installation rejected under clause A33 at no cost to the contract including all costs arising from any associated building works or the works of other trades, together with all costs arising from delay in the replacement of rejected items.

320 Supports and fixings

Comply with specification sections Y63 and Y93.

Supply and install complete all necessary support steelwork, including brackets and suspension/ threaded rods etc to support the electrical installation defined in this specification and shown on the drawings.

Provide corrosion resistance to the minimum levels appropriate to the environment as specified in relevant standards (eg BS EN 61537 minimum Class 1 (electroplated) for internal heated spaces and minimum Class 5 (post galvanised zinc costing) for external areas unless otherwise defined in the 'engineering system' sections of this specification).

Do not fix electrical services to any support steelwork that is subject to vibration or heat transfer.

Do not support electrical services from any suspended tile ceiling system but provide independent support fixings.

400 ANCILLARIES

410 Fire and smoke barriers

Fit sleeves or transit frames around cables (including those supported by trays, wire trays or cable ladders), and fire-seal the gap between them and the cable(s), as appropriate, wherever electrical installations pass through fire and smoke barriers (including compartment walls and compartment floors). Provide and fit, at all fire or smoke barriers, internal fire stopping to conduits, trunking, ducts and busbar products that have internal space that can conduct combustion products.

Carry out all such work to the requirements of Building Regulations Part B and those of BS 7671.

Arrange the integrity of the fire and smoke barriers through which such cables, conduits, trunking, busbar systems, etc, pass, by advising the Contract Administrator of the need to arrange for making good around the sleeves, transit frames and trunkings with appropriate fire stopping materials.

420 Expansion joints

Ensure that every expansion joint in conduits, trays, trunkings and busbar enclosures/trunking is of a recognised pattern supplied by the appropriate equipment manufacturer.

Loosely clamp within the adjacent fixing saddles/cleats to allow movement, and where necessary install formed loops' at each cleated cable crossing at expansion joints.

430 Enclosures

Install all site-fitted electrical components (including relays, contactors, RCDs) that are not installed within a distribution board, consumer unit or control panel, within a proprietary enclosure. Ensure that every such enclosure is ingress protected to suit its location, is manufactured from a material that resists combustion, and is equipped with DIN rails or detachable mounting frames for mounting the equipment.

440 Other sundry components

Ensure that all other sundry components used are proprietary and are of a recognised pattern, supplied by the appropriate service manufacturer.

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Y89 SUNDRY COMMON ELECTRICAL ITEMS

500 WORKMANSHIP

Comply with the positions and heights given in Y89, and Approved Document M, unless otherwise agreed in writing with the Contract Administrator. Prior to installation of any sockets, switches, controls, etc, agree the positions with the building control authority responsible for the project.

510 Positioning

Comply with the requirements of specification sections A11 and A13.

Check and confirm all measurements and work to the larger scale, formally issued, detail plans in the possession of the clerk of works or main contractor to verify the positional dimensions of accessories and associated electrical equipment. Do this before commencing work. In the absence of large-scale drawings being available, agree all positions with the Architect.

Do not scale dimensions from the drawings as the symbols representing electrical accessories and equipment on drawings are not drawn to scale.

Install wall mounted socket outlets, switches, telephone outlets, TV outlets and control items (eg adjustable thermostats) with their nearest edge at least 350 mm horizontally from room 'internal angle' corners.

Position at least one outlet above kitchen work surfaces at the return end (work surface end abuts wall) where the work surface does not have wheelchair manoeuvring space beneath. Position the outlet with its centre no more than 150 mm horizontally from the front edge of the work surface, and no more than 100 mm above the work surface.

Install door entry phones, card readers and manual controls for powered door systems within 200 mm horizontally of the associated door frame, except that, where the door opens towards the user, set-back such items 1400 mm horizontally from the swinging stile (leading edge) of the door (so that wheelchair users do not have to move to avoid contact with the door as it opens.)

Install lighting pull cords at 150 mm maximum horizontally, from the door frame of the swinging stile (leading edge) of the associated door and as close to the wall as possible.

520 Mounting heights in walls

Locate and mount all switches, outlets and controls as shown on architectural setting out drawings, if available, and to satisfy Building Regulations Approved Document M and BS 7671. In the absence of large-scale drawings being available, all positions are to be agreed with the Contract Administrator.

Select mounting heights for landing push buttons, keypads and 'indicator arrows' associated with lifts, and for emergency stop buttons associated with escalators and conveyers, to satisfy relevant standards, codes and manufacturer's recommendations.

In car parks and garages mount all socket-outlets at 1.2 m above floor level to avoid mechanical impact from the movement of motor vehicles. Confirm with building control and other relevant authorities that mounting of socket-outlets in this manner is acceptable.

Comply with the London District Surveyors Association Fire Safety Guide No 1 *Fire Safety in Section 20 Buildings*, section 3.07: Car parks, that requires:

- ~ 1. Electrical apparatus (including luminaires) if installed below the general car park floor level, or in other similarly hazardous positions, should be of a type suitable for use in potentially explosive atmospheres (apparatus Group 11A) Zone 1 areas in accordance with BS 5345.
- ~ 2. Electrical apparatus (including luminaires) if installed at floor level or within 1.2m above floor level should be of a type suitable for use in potentially explosive atmospheres (apparatus Group 11A) Zone 2 areas in accordance with BS 5345.

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- ~ 3. All electrical apparatus in the car park shall be suitably protected from mechanical damage.
- ~ 4. Any electrical equipment installed within the air stream of a mechanical extract ventilation system should be of a type suitable for use in potentially explosive atmospheres (apparatus Group 11A) Zone 1 areas in accordance with BS 5345.

Mount all items of the same category and within the same room, at the same height unless otherwise agreed with the Contract Administrator.

Mount all accessories at the heights Above Finished Floor Level (AFFL) given in this clause unless otherwise detailed in the 'engineering systems' sections of this specification or otherwise stated.

Apply the heights given in this clause to the accessory and not to the conduit box to which it is fitted.

Ensure that the bottom edge of the accessory is no lower than the lowest AFFL in the range, and the top edge of the accessory is no higher than the highest AFFL in the range, unless stated otherwise. Apply them but make due allowance for coordinating with any building feature, eg wall tiling.

Do not mount accessories within 50 mm of the upper edge of tiling. Do not mount accessories within 100 mm of the underside of a worktop.

CAWS	CATEGORY OF ITEM/ ACCESSORY	mm AFFL	NOTES
V20	Utility meters	1200 – 1400	
	Distribution boards	400 – 1800	Dependant on size of the distribution board with meters
	Consumer units (non-domestic)	750 – 1200	As BS 8300
	Consumer units mounting height from FFL to switches (in dwellings)	1350 – 1450	Approved Document M recommends that switches sockets and other equipment should be located between 450 mm and 1200 mm from finished floor level. Approved Document P suggests one way to comply is by mounting the consumer unit so that the switches are between 1350 mm and 1450 mm from the finished floor level.
V21	Lighting switches	900 – 1200	And level with door handles
	Lighting pull cords	900 – 1100	To lower end of cord
	Access for those with reduced reach	450 - 1200	Serving habitable rooms
V22	Socket outlets and switched socket outlets	400 – 1200	
	Switches for permanently wired appliances (eg fused connection units)	400 – 1200	Higher if needed for particular appliances
	Socket outlets, switched socket outlets and switches for permanently wired appliances	100 – 200	To centre above work surfaces in kitchens and laboratories

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	Isolators, push buttons, starters, cooker control units	750 – 1200	
	Cooker connection units	450 – 750	
	Shaver socket outlets, hot air hand driers	800 – 1000	To bottom edge
	Flex-outlets		To suit the circumstances
	Powered window controls	800 – 1000	
V40	Safety signs (emergency exit signs)	2000 – 2500	To bottom edge or as risk assessed under BS 5266
W10	Doorbell pushes, door entry 'phones	400 – 1200	Depending on accessibility requirements
	Telephone outlets (non-domestic)	400 – 1200	
W11 & W14	Emergency assistance alarm pull cord	100	To lower red bangle
		800 – 1000	To upper red bangle
	Emergency assistance alarm reset button	800 – 1000	To bottom edge
W20	TV outlets (non-domestic)	400 – 1200	
W23	Clocks	2500	
W40	Manual controls (including push pads and green emergency break glass units) for powered door systems	750 – 1400	Reset back 1400 mm from leading edge of door when fully open
	Swipe card readers	950 – 1000	To centre of reader
W50	Fire alarm manual call points	900 – 1200	And level with door handles *
	Alarm sounders	2500	To centre
	Visual alarms	2100	Minimum
W60	Room thermostats and humidistats that room occupants adjust	1400	To top of thermostat or humidistat
	Room thermostats, temperature and humidity sensors that are not adjustable by room occupants		At height recommended by manufacturer, approximately 1200 – 1800 mm (with default height of 1800 mm)

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X10	Lift controls (non-domestic)	900 – 1100 mm from the FFL and 500 mm from any return wall	As Approved Document M, Volume 2, 3.34.g
	Lift controls in dwellings	900 – 1200 mm and 400 mm from the front wall	As Approved Document M, Volume 1, 1.11.k

NOTE * Where fire alarm manual call points are mounted at lower than 1100 mm record this as a variation from the BS 5839 requirement of 1400 mm, (a variation of less than 300 mm need not be recorded as a variation), in the 'Design Certificate' and have it approved by the controlling fire authority.

END OF SECTION Y89

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MANCHETSER ROYAL INFIRMARY

Y90 FIXING TO BUILDING FABRIC

Y90 FIXING TO BUILDING FABRIC

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly, for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender.

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (e.g. S10, T31, V21, etc) of this specification, the standard referred to in the engineering system section prevails.

Construction Products Regulations

BS EN ISO 4016	Hexagon head bolts. Product grade C
BS EN ISO 4034	Hexagon regular nuts (style 1). Product grade C
BS EN ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel. Bolts, screws and studs with specified property classes. Coarse thread and fine pitch thread
BS EN ISO 898-2	Mechanical properties of fasteners made of carbon steel and alloy steel. Nuts with specified property classes. Coarse thread and fine pitch thread
BS EN ISO 898-5	Mechanical properties of fasteners made of carbon steel and alloy steel. Setscrews and similar threaded fasteners with specified hardness classes. Coarse thread and fine pitch thread
BS EN ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners. Bolts, screws and studs
BS EN ISO 3506-1	Mechanical properties of corrosion-resistant stainless steel fasteners. Nuts
BS EN 20898-7	Mechanical properties of fasteners. Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm
BS 1473	Specification for wrought aluminium and aluminium alloys for general engineering purposes - rivet, bolt and screw stock
BS 4078-1	Powder actuated fixing systems. Code of practice for safe use.
BS 4190	ISO metric black hexagon bolts, screws and nuts. Specification
BS 5080-1	Structural fixings in concrete and masonry. Method of test for tensile loading
BS 8000-0	Workmanship on building sites. Introduction and general principles
BS 8539	Code of practice for the selection and installation of post-installed anchors in concrete and masonry
BG 10/2010	BSRIA Structural Fixings for Ductwork Systems
CFA GN	Construction Fixings Association (CFA) Guidance Note: Procedure for site testing construction fixings

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Y90 FIXING TO BUILDING FABRIC

200 PRODUCTS AND MATERIALS

210 General

Where an 'engineering system' specification section or a 'service reference' specification section specifically refers to fixings and adhesives for a particular application, comply with the requirements of that specification. Use this specification section for fixings and adhesives in other applications where the specification is otherwise silent on such matters.

Supply all necessary and appropriate fasteners, fixings, bearings, brackets, etc. necessary for the safe and proper installation plus associated flashings and closures. Carry out fixings in straight lines, or at regular centres.

Ensure all materials and components forming part of external construction are of corrosion resistant material or have a corrosion resistant finish.

Confirm that all materials have bimetallic corrosion resistance appropriate to items being fixed.

Use fixing and jointing methods and types, sizes, quantities and spacings of fasteners which are suitable having regard to:

- ~ the nature of and compatibility with product/material being fixed and fixed to, including vibrations in use
- ~ manufacturer's instructions
- ~ materials and loads to be supported
- ~ conditions expected in use
- ~ appearance, this being subject to acceptance by the Contract Administrator

220 Methods of fixing

221 Fixing types

Where appropriate securely fix all engineering components to the building fabric using any of the following methods:

1. expanding anchors and bolts for heavy loads fixed to masonry or concrete
2. white finished metal or plastic wall plugs and screws for light loads to masonry or concrete
3. screws into wood for light fixings
4. clamps and adaptors to fix to structural steelwork, if accepted by the Contract Administrator in writing
5. proprietary adaptors for proprietary cast in fixings when provided as part of the building

Employ all fixings within the loading recommendations and substrate recommendations of the manufacturer.

222 Fixing methods not allowed

Do not use the following fixing methods:

1. drilling structural steel work
2. hanging supports with loose back plates under floor screed
3. wooden or fibre wall plugs
4. built-in fixings unless specifically detailed in the specification or on the drawings

PROJECT RED ELECTRICAL INFRASTRUCTURE

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Y90 FIXING TO BUILDING FABRIC

230 Masonry fixings

Select plugs and screws for light duty applications.

Select expansion anchors or chemical anchors for heavy duty applications.

231 Plugs

Use proprietary type plugs to suit the substrate. Confirm that loads are adequately supported and that fixings are suitable for the expected conditions in use.

Locate plugs accurately in correctly sized holes in accordance with the manufacturer's instructions.

232 Anchors

Use adhesive or chemicals in substrates where the expansion of an anchor would cause fractures, or for use in irregular substrates where expansion anchors cannot transfer loads adequately.

Select the type and size of the anchor considering:

- ~ the strength of the concrete being fixed to
- ~ the loads to be applied to each anchor
- ~ the allowance to be made for bending stresses caused by packing shims; the available edge clearance from the drilled hole
- ~ and the spacing of the fixings

Install the anchor in accordance with the manufacturer's instructions. Before fitting the anchor into the drilled hole, clear all dust and fragments from hole. Insert anchor, through material to be fixed if appropriate, and tap or set in accordance with the manufacturer's instructions. Tighten to the correct torque setting in accordance with the manufacturer's instructions.

240 Powder-actuated fixing

Do not use powder-actuated (explosive) fixing systems without written acceptance from the Contract Administrator. Where their use has been accepted, only use for light fixings.

Only use fully trained and certified operators who are proven competent in the safe use of powder-actuated systems for the fixings selected.

Prior to use on site perform a site trial to determine suitability of powder fixing and the need or not for pre-drilling. Do not use powder-actuated fixing if site trial results are unsatisfactory.

Pre-drill powder-actuated fixings as required.

Select fasteners and accessories recommended for the application by the tool manufacturer.

Apply a zinc rich primer to heads of fasteners used externally, in external walls or in other locations subject to dampness.

Use top-hat section plastics washers to isolate cartridge-fired nails from stainless steel components fixed externally, in external walls or in other locations subject to dampness.

250 Composite / concrete slab embedded channel

Use only proprietary cast-in channels and other fixings if provided as part of the building specification.

Use only proprietary loose fixings such as wedge and T-nuts approved for use with cast-in channels and other fixings by cast-in channel manufacturer.

Liaise with the building contractor regarding the locations of cast-in channels prior to these being built-into the building structure.

PROJECT RED ELECTRICAL INFRASTRUCTURE

MANCHETSER ROYAL INFIRMARY

Y90 FIXING TO BUILDING FABRIC

260 Cavity fixings

Do not use cavity wall fixings without written acceptance from the Contract Administrator.

Where possible arrange for fixings to occur directly into the main load-bearing supporting framework of the cavity construction or via suitably located secondary load-bearing supports attached to the main framework.

Select metallic spring-toggle anchors for light duty applications.

Select metallic hollow-wall anchors for medium duty applications.

Install the anchor in accordance with the manufacturer's instructions. Retain anchors in a cavity by ensuring the locking mechanism, i.e. toggles of spring-toggle anchors or expanding arms of hollow-wall anchors, are firmly engaged against the inside face of the cavity.

270 Screws

Select screws to suit the fixing requirement of the components and substrate.

Use parallel, fully-threaded shank or twin-thread type wood screws for fixings into timber.

Use self-tapping, metallic drive screws, or power-driven screws as required. Do not hammer screws unless they are specifically designed to be hammered.

Ensure all screws have clearance holes. Provide pilot holes about half the diameter of the shank for screws of 8 gauge or more, and all screws used for hardwood.

Use washers and screw cups, where required, of the same material as the screw.

280 Adhesives

Only use adhesives where dismantling is not required and where the application does not demand an alternative method of mechanical fixing, or for those applications where adhesive is fully accepted.

Select adhesive types as recommended by the component supplier and/ or manufacturer, that are compatible with the finished surfaces and preservative/ fire retardant treatments, and that will not compromise the performance requirements of the elements to be bonded.

Prepare surfaces to receive adhesive to be free from dust, grease and any other contamination likely to affect bonding. Where necessary, clean surfaces using methods and materials recommended by the adhesive manufacturer.

Adjust the regularity and texture of the surfaces as required to suit the bonding and gap filling characteristics of the adhesive. Apply adhesives using the manufacturer's recommended spreaders/applicators to ensure correct coverage.

Bring surfaces together within the recommended time and apply pressure evenly over full area of contact to ensure full bonding. Provide supports and clamps as necessary during setting. Do not mark surfaces or distort components being fixed.

Remove surplus adhesive using methods and materials recommended by the adhesive manufacturer and without damaging surfaces.

290 Packing

Provide suitable non-compressible and corrosion proof, tight packings at fixing points to take up tolerances and prevent distortion. Do not allow packings to intrude into zones that are to be filled with sealant.

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Y90 FIXING TO BUILDING FABRIC

300 WORKMANSHIP

Carry out the workmanship in compliance with the requirements of the appropriate reference documents specified in clause 100.

Observe the manufacturer's and statutory requirements for storage and safe usage of materials.

Do not use adhesives in unsuitable environmental conditions or beyond the storage period recommended by the manufacturer.

Drill all holes required for fixings.

Do not hammer screws and fixings unless they are specifically designed to be hammered.

Remove all unspent fixings and adhesives from the site when no longer required.

Avoid moisture penetration by suitably tightening screws and bolts, or using protective caps. Do not overtighten bolts in timber to avoid local compression of the timber.

400 INTERFACE WITH FIXED SERVICES

Comply with section Y93 of this specification.

500 TESTING

Undertake proof testing in accordance with BS 8539 and CFA Guidance Note: Procedure for site testing construction fixings.

Use only competent testers, assessed and certified by the CFA Approved Tester scheme for testing. Provide documentary evidence of a tester's certification to the Contract Administrator at least 4 weeks prior to commencement of testing.

600 SCHEDULE OF INSTALLERS SUBMISSIONS

Submit to the Contract Administrator no less than 28 days prior to the date of practical completion:

- ~ all documentary evidence of proof tests, methodology and results
- ~ detailed technical specifications and record drawings
- ~ detailed installation instructions including COSHH Assessments and data sheets
- ~ detailed maintenance and operating instructions including safety requirements necessary to carry out the works
- ~ schedules of plant and materials suppliers
- ~ load tests for fixings where required
- ~ guarantees and warranties

END OF SECTION Y90

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100 REFERENCE DOCUMENTS

This specification is written based on legislation, standards and guidance in force in the UK generally, and within England by default. For projects in Scotland, Wales, Northern Ireland, the Channel Islands and the Isle of Man, give appropriate consideration to any locally applicable legislation, standards and guidance that deviates from or is additional to those in force within England. Similarly for projects outside the UK comply with the corresponding national legislation, standards and guidance.

Comply fully with the edition (including amendments, replacements and associated normative references) of each of the following, current at the time of tender:

Where a standard referred to in this section conflicts with a standard referred to in an associated 'engineering system' section (e.g. S10, S63, T31, V21, W63, Y10, Y30, Y52, Y60, Y62, Y63, Y89, etc.) of this specification, the standard referred to in the engineering system section prevails.

BS 476-24	Fire tests on building materials and structures. Method for determination of the fire resistance of ventilation ducts
BS 4078-1	Powder actuated fixing systems. Code of practice for safe use
BS 4078-2	Powder actuated fixing systems. Specification for tools
BS 8539	Code of practice for the selection and installation of post-installed anchors in concrete and masonry
BS EN 12236	Ventilation for buildings. Ductwork hangers and supports. Requirements for strength
BS EN 12385	Steel wire ropes. Safety
BS EN 13411	Terminations for steel wire ropes - Safety
BS EN 14713	Zinc coatings
BS EN 10210	Hot finished structural hollow sections of non-alloy and fine grain steels
BS EN 13501-3	Fire classification of construction products and building elements. Classification using data from fire resistance tests on products and elements used in building service installations: fire resisting ducts and fire dampers
BS EN ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods
BS EN ISO 10244	Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings
BS EN ISO 27830	Metallic and other inorganic coatings. Requirements for the designation of metallic and inorganic coatings
ISO 17893	Steel wire ropes. Vocabulary, designation and classifications
BESA DW/144	Specification for sheet metal ductwork
Association for Specialist Fire Protection (ASFP) Blue Book:	
ASFP	Blue book. Fire Resisting Ductwork: classified according to BS EN 13501 Parts 3 and 4
ASFP	Blue book. Fire Resisting Ductwork: tested to BS 476 Parts 24
BSRIA BG 10/2010	Structural fixings for ductwork systems
BSRIA COP 22/2002	Wire rope suspension systems. A code of practice for service installers

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HSE ACOP L113	Safe use of lifting equipment: Lifting Operations and Lifting Equipment Regulations 1998
CFA GN	Construction Fixings Association (CFA) Guidance Note: Procedure for site testing construction fixings

200 GENERAL ITEMS

Provide for the support and/or suspension of services and the safe transfer of services dead load and dynamic load to the building structure. Support means holding in place from below the horizontal under compression stress and/or bending stress. Suspension means holding in place from above the horizontal under tension stress and/or bending stress. Allow for all shear stress and lateral loadings as may occur subject to physical arrangements implemented.

The transfer of supported and suspended loads must not adversely affect either the structure or fabric to which it attaches, nor the performance of the service being supported or suspended.

All support and suspension systems must ensure both the initial and ongoing safety of the supported and/or suspended services.

The support and suspension system must not diminish the thermal, acoustic or mechanical performance of the suspended or supported service. The support and suspension system must not introduce condensation nor facilitate its formation.

Install the support and suspension system to transfer loads thus:

- ~ (A.) From the service or, (AA.) from associated intermediate physical support (e.g. cable tray, ductwork hanger, pipework clamp)
- ~ (B.) To and via the support or suspension component (e.g. threaded rod, wire rope, catenary system, channel (unistrut))
- ~ (C.) To the fixing with the structure/fabric

Structure includes all secondary support and access steel work designed, fabricated, supplied and installed to support the engineering services within this works package. A requirement for Installer to provide secondary steelwork, where not specifically detailed on the Structural Engineering drawings, is set out in Section A20 Preliminaries / General Conditions.

Design, configure and install the support and suspension systems in accordance with the specifications shown in the following matrix.

(C.) Fixing to structure/fabric	(B.) Support / suspension component	(A.) Termination/connection to Service	(AA.) Intermediate support
Comply with: Y93 A20 Preliminaries / General Conditions Y90 Fixing to building fabric	Comply with: Y93	Comply with: Y93 Where not otherwise specified under AA, Includes but not limited to: Wire rope looped over ductwork.	Comply with: Y89 Luminaires and lamps. Specifies the support of luminaires from conduit, trunking, and direct fixing. Specifies the use of rod, chain and flexible cord. Y63 Support Components – cables

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		Wire rope connected to integral lifting eye integral to, say, fan coil unit. Direct bolting of threaded rod to say, VAV box	Specifies the SWL of cable tray and cable ladder. Specifies the support for cable runway and cable ladders. Specifies the electrical requirements integral to the use of cable support components regarding PE and bonding also specified.
			W63 Wiring for mechanical systems Cross refers to Y63 for support system details.
			S63 Sprinklers Specifies compliance with LPC rules for pipe supports. Specifies additional fixings / support to final sprinkler position.
			Y62 Busbar trunking Specifies installation of busbar as per specification and manufacturer's instructions. Specifies proprietary and non-proprietary brackets.
			Y30 Ductwork Specifies all ductwork and associated components as detailed in DW/144 and BS EN 10210

Design, specify, procure, install and test the support and suspension system and all its component parts to comply with BS 8539 as applicable. (BS 8539 is considered to be an appropriate standard because it refers to applications vulnerable to progressive collapse including suspended ceilings, and suspended services such as pipework, ductwork or cable tray.)

Ensure that the support and suspension system is designed, specified and installed to prevent progressive collapse and the potential risk to human life in the event of such collapse. Commission specialist design services from manufacturers or other competent professionals to ensure that the support and suspension system as installed eliminates all material and unmanageable risk of progressive collapse.

Design, specify, procure and install all component parts to comply fully with manufacturer's instructions for design and installation.

210 Loadings

Provide all suspension and support components with sufficient Safe Working Load (SWL), Working Load Limit (WLL), or other approved loading classification sufficient to support all design loads. These loads arise from services to include, but not limited to, the following:

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- ~ Air handling units
- ~ Fan coil units
- ~ Ductwork
- ~ Heating/cooling emitters
- ~ Pipework
- ~ Cable trays, basket and ladder
- ~ Lighting
- ~ Signs
- ~ Grid support systems

Ensure that all fixings and fixing points to the building structure or fabric are approved or otherwise classified as fit for purpose and correctly installed to maintain such approval or classification.

Ensure that all suspended and supported services have sufficient strength and appropriate rigidity at each point of suspension and/or support for transfer of its loads to the suspension and/or support system.

Use suspension and support components in accordance with the manufacturer's instructions taking due account of all:

- ~ Vertical loads
- ~ Lateral loads
- ~ Dynamic loads
- ~ Tensile, compressive and shear loads

Include for loads arising from fluid content, insulation, acoustic quilt and installation, maintenance and servicing loads e.g. persons inside ductwork performing cleaning activities.

Subject to receiving normal maintenance, as recommended by the manufacturers, and in-service use in accordance with the design conditions provide all support and suspension systems to sustain their design performance properties throughout their expected service life.

220 Support and suspension elements

Support services from below and include the following main components:

- ~ Fixing to structure or fabric e.g. anchor or clamp
- ~ Support element such as Unistrut, angled bracket or threaded rod
- ~ Attachment to or around service such as ductwork support e.g. circular duct ring; profiled straight channel, cable tray profiled hanger.

Suspend services from above and include the following main components:

- ~ Fixing to structure or fabric e.g. anchor or clamp
- ~ Suspension element such as wire or threaded rod
- ~ Attachment to or around service such as ductwork support e.g. circular duct ring; profiled straight channel, cable tray profiled hanger.

Use solid wire, wire rope, threaded rod or similar products designed specifically, or otherwise approved by manufacturer, for supporting suspended loads.

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Use stranded wire support systems only by prior agreement with the Contract Administrator and in applications limited to non-fire rated ductwork branches which have supplementary means of lateral support. Do not use for supporting fire rated ductwork, pipework or electrical containment services. Do not joint wire rope, or other similar continuous reel supplied suspension elements to increase their length. Use only continuous reel length suspension elements.

Joints to any non-continuous support or suspension element, such as threaded rod, must be made with products designed specifically, or otherwise approved by manufacturer, for securely jointing and holding supported or suspended load.

230 Support and suspension terminations

Provide all hooking loops within wire rope systems with a solid thimble eye.

Use closed eye fixings on suspended services. Where closed eye fixings are not practicable for application use double loop (Pigs tail) open hook fixings.

Attach a ferrule or other such means to the loose end of any wire rope to prevent fraying.

Protect all sharp edges and protrusions (including surfaces, edges, crevices, points, wire ends, screw heads, corners, brackets, braided cable, clamps, pins, drop rods etc.) by fitting suitable safety measures such as, but not limited to, corner saddles, chamfering, cutting back excess lengths as appropriate, or providing protective caps where relevant. Additionally, where sharp edges and protrusions exist, provide warning tapes (black/yellow) and soft padding to areas based on the risks posed.

240 Types of structure

Liaise with the project Structural Engineer to ensure that the structural elements to be used for supporting services loads are capable of this.

Only attach the suspension system to the following types of structure after confirming suitability:

- ~ Exposed primary steelwork (e.g. main structural columns and beams)
- ~ Exposed secondary steelwork (e.g. light gauge steel such as roof purlins, facade side rails)
- ~ Profiled/composite decking
- ~ Concrete
- ~ Other structural elements

Do not drill any structural steel work without permission from the Structural Engineer.

Do not attach suspension system to the following:

- ~ Any non-suitable structure or fabric
- ~ Any structural engineer/architect barred structures

250 Catenary systems

Confirm building suitability with structural engineer before using horizontal catenary support system suspended between two building fixing points. Allow for all lateral, compressive, tension, and shear loads.

Install catenary support wires with the straight line between their two end support points within plus or minus 5 degrees of horizontal.

Ensure all items attached to catenary support wires are designed to be non-slip, self-gripping or otherwise prevented from slipping by locking devices specifically designed for prevention of slippage on catenary wires.

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Use only trained competent installers experienced in the design and installation of catenary support systems.

260 Installation

Design, install and adjust the suspension system to fix services to the required design height and orientation.

Where mechanical lifting assistance is required provide, in accordance with HSE ACOP L113, all necessary temporary suspension arrangements during installation of the suspension system as required. Transfer the mechanically lifted load to the suspension system gradually and evenly.

Locate fixings directly above the suspension point. If this is not possible then check with the manufacturer the suitability of the fixings to accept lateral loads at the angle involved.

Use only parts from the same manufacturer for each independent suspension system. Only mix different manufacturer parts if all are fully compatible without degradation of performance or manufacturer warranty.

Use components from a single manufacturer.

Ensure that all suspension rods, wire ropes and other suspension components are evenly tensioned with no nicks, cuts, fraying, twisting, deformation, or deflection of wire ropes by other objects.

300 ATTACHMENT TO STRUCTURE

310 Methodology

Attach the suspension support system building structure by one or more of the following methods providing in all cases that the manufacturer's instructions, BSRIA COP and standards are adhered to:

- ~ Direct attachment e.g. cable looped over a beam
- ~ Expansion anchors and screw fixing to concrete
- ~ Adhesive bonding anchors
- ~ Holorib or composite system e.g. embedded channel in slab for use with wedge fixings, T-head bolts, or similar fixings on the underside
- ~ Powder fixing (where such use is permitted)
- ~ Clamps and clips
- ~ Other

Ensure that reinforcement bars are not damaged, cut or otherwise affected as part of the attachment fixing. Report all damage to the Structural Engineer.

Comply with BS 5080 for all fixings in concrete and masonry.

Select and install fixings in accordance with BS 8539 Code of practice.

Provide slip restraints where rope wire attachment to structure is not perpendicular to structure.

320 Direct attachment

Ensure that no cutting, digging in, or other deformation to either wire loop or item being looped occurs.

Use manufacturers recommended corner saddles, preformed eyes or other recommended corner protection.

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330 Expansion anchors and screw fixing

Comply with specification section Y90.

340 Composite systems

Comply with specification section Y90.

400 APPLICATION SPECIFICS

410 Safety margin and redundancy

Provide a minimum level of redundancy that will ensure the transfer of suspended load to immediately adjacent supports in the event of failure of any single system component. The immediately adjacent support must sustain the additional load.

420 Fire rating

All elements of the support and/or suspension system used for fire resisting ductwork must be capable of bearing the load of the ductwork under specified fire conditions relating to such ductwork. Guidance set out in the following Association for Specialist Fire Protection Blue Book publications show the factors relevant to supporting fire resisting ductwork:

- ~ Fire Resisting Ductwork: classified according to BS EN 13501-3
- ~ Fire Resisting Ductwork: tested to BS 476-24

All elements of the support and/or suspension system used for support and/or suspension of services must be capable of bearing the load of the service under any specified fire conditions relating to that service.

Provide all such certification and other manufacturers evidence of the fire rating for different exposure times under conditions of standard fire test procedures.

500 CORROSION RESISTANCE

Provide details of proposed materials and corrosion performance of suspension components at tender stage to Contract Administrator for comment.

600 TESTING

Use only certified competent and approved testers for testing. Provide documentary evidence of the testers' certification, competence and approval to the Contract Administrator at least four weeks prior to the commencement of testing.

Carry out all testing of fixings and anchors to concrete and masonry to BS 8539.

610 Preliminary testing

Provide details of all preliminary testing required at least four weeks before carrying out testing.

Undertake preliminary testing in accordance with CFA Guidance Note: Procedure for site testing construction fixings.

620 Proof testing

Perform proof tests on a representative sample to at least 2.5% of fixings. Provide details of the proposed proof testing with the tender submission.

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In the event of any fixture failing under test, double the test sample size. Investigate and determine the cause of failure and ensure the elimination of failure cause from all other fixings of the same type. Where the cause cannot be eliminated use alternative fixings and subject those to proof tests.

Undertake proof testing in accordance with BS 8539 and CFA Guidance Note: Procedure for site testing construction fixings.

700 SCHEDULE OF INSTALLER'S SUBMISSIONS

710 Design proposals and specialist contractors

Provide to the Contract Administrator at least 4 weeks before implementation, details of all proposed support and suspension systems to include the following:

- ~ details of any suspension or support systems specialist to be used and the nature of their engagement
- ~ details of the proposed systems and how they comply with this specification
- ~ details of system manufacturers' certification of proposed system components
- ~ details of any consultation and agreement with the structural engineer where required e.g. in respect of lateral loads imposed by catenary systems
- ~ details of physical layout and orientation of all systems elements

720 Certificates and test results

Provide documentary evidence of tester's certification, competence and approval to the Contract Administrator at least 4 weeks prior to commencement of testing.

Provide all design assumptions, documentation of installed components and installation and maintenance guides.

Provide all documentary evidence of proof tests, methodology and results.

Provide all documentary evidence of preliminary tests, methodology and results.

Provide all tester's certificates

730 Maintenance and inspection

Provide details of all recommended inspection regimes necessary to ensure the long term integrity of the support and suspension system.

END OF SECTION Y93



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