Introduction

The Standard Specification is published in a series of 21 stand-alone modules each addressing single distinct areas of the construction process. This stand-alone module 16 addresses the main aspects of electrical installation in general.

The purpose of the MoW STANDARD SPECIFICATIONS FOR CONSTRUCTION is to provide the design professional with a guide for accepted construction practices for Ministry of Works projects. As an aid to the designer, these Standard Specifications are provided for the inclusion in proposed development projects for ease, efficiency and cost savings.

The Standard Specifications are not intended to limit the design responsibility of the design professional. However, they establish a minimum acceptable criterion and/or quality for use within Ministry of Works projects.

The design professional may increase the requirements of an item contained in the Standard Specifications to meet job requirements, but when this is done, there should be no reference for that item on the drawings to the Ministry of Works Standard Specifications and a new specification should be included with the drawings or project contract documents.

The design professional must review all Standard Specifications to be sure that they are adequate for the proposed project based on the job site conditions; the design professional is solely responsible for the designs submitted under his seal.

In order to keep design standards current with changing regulations and improved construction materials and practices this section will be updated and maintained by the concerned authorities of the Ministry of Works. Prior to starting a new project, the design professional should contact the concerned Directorate of the Ministry of Works to verify that he/she has the latest document revisions.
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Foreword

This specification provides the basis for electrical work in building construction. It relates to the provision of all plant, labour and materials involved in connection with the electrical work.

This specification must be read in its entirety, as it is structured in order of work-flow, which means that items or activities appear in several places in the specification corresponding to the progression of the construction process.

For larger or more complex or specialist projects, a project-specific Particular Specification for electrical work may also be provided.

Absence of clauses for materials and methods does not necessarily signify that they can not be used. Proposals for use of innovative methods and materials are encouraged and are subject to review and approval by the Client.

Where the word approved is used in this specification, this means that the Client or Engineer has been consulted and has confirmed that the item or procedure is acceptable in the specific context for which approval has been requested.
1. **PART 1 MATERIALS**

1.1 **Source of Approvals**

All materials and work shall comply with all the current relevant British Standards (BS), specifications and regulations issued by the Electricity Distribution Directorate (EDD).

The contractor shall confirm the characteristics of the power supply before ordering equipment dependant on these factors.

1.1.1 **Utility Power Distribution**

1.1.1.1 **Electrical Supply**

The characteristics of the power supply as provided by the Electricity Directorate are as follows:

- 400 V ± 6% 3 phase, 4 wire, 50 Hz ± 2% System
- 230 V ± 6% 1 phase, 2 wire, 50 Hz ± 2% System
- Fault level: 31 MVA at 400 V for 0.5 sec duration

The contractor shall, however, confirm these before ordering equipment depending on these factors.

1.1.1.2 **Transformers**

Transformers shall be provided in accordance with the Electricity Distribution Directorate’s Regulations for Electrical Installations as currently amended.

The transformers shall be constructed to BS EN 60076 or BS 6436 as applicable.

The transformers shall be 11,000 V primary to a 400 V secondary, DYN 11 type transformer, either cast resin or oil filled as required.

The power supply system shall be 400 V, 3-phase, 50 Hz, arranged in a TN-S configuration, with separate neutral and protective conductors throughout the system.

Cast resin or dry type shall comply with the following standards:

- IEC 60076  Power Transformers
- BS EN 60076  Power Transformers

Three phase, double wound windings shall be provided, connected and marked to vector group reference Dyn 11 BS EN 60076 unless otherwise indicated on the drawings.

Off-load tappings shall be provided on higher voltage winding for a variation of ± 2.5% and ± 5% of the primary voltage.

Fire behaviour class shall be to BS 7844; Class F1 or Class F2

Oil or synthetic liquid immersed shall comply with the following standards:

- BS EN 60076 and IEC 60076 – Power Transformers
- BS 7821 – Oil-immersed distribution transformers

Three phase, double wound windings should be provided, connected and marked to vector group reference Dyn 11 BS EN 60076 or as otherwise indicated on the drawings.
Off-load tappings shall be provided on higher voltage winding for a variation of ± 2.5% and ± 5% of the primary voltage.

Fire behaviour class shall be provided to BS EN 50464; Class F1 or Class F2

1.1.1.3 HV Switchgear

HV switch and control gear shall be provided in accordance with the Electricity Distribution Directorate’s Regulations for Electrical Installations as currently amended.

HV switchgear shall comply with BS 159, BS EN 62271, BS EN 60265, BS EN 62271: Part 200 and BS EN 60694 where applicable.

Enclosure shall provide protection in accordance with BS EN 60529, indoor boards to be rated to minimum IP 31 and external boards to be rated to minimum IP 65.

Facilities shall be provided on switchboards (excluding ring main units), to allow future extension of switchboards at either end. The enclosures shall be cubicle or multi-cubicle type assemblies.

Certificates shall be provided of verification of type test for short circuit strength of components of each assembly. Ensure that drawings and other documents forming part of certificate are available prior to order being placed.

Certificates issued by The Association of Short Circuit Testing Authorities (Inc) ASTA are preferred.

Triple pole, fully insulated busbars shall be provided within the switchgear as indicated on drawings. The material used shall be high conductivity solid copper in accordance with BS 159 and BS EN 13601 or Tinned high conductivity solid copper in accordance with BS 159 and BS EN 13601.

Busbar unit length shall have non-hygroscopic insulation. Busbar joints and connections to circuit-breakers and other units shall be insulated in accordance with BS 159.

Busbars shall be installed in separate compartments of switchgear with removable access covers along length, with identification and warning labels on access covers.

An earthing bar made of copper to BS EN 13601 shall be securely fixed through full length of switchgear, each end connected to an earthing terminal. All metalwork other than current carrying parts shall be bonded to an earthing bar. Armouring and metal sheaths shall be provided for all incoming and outgoing cables bonded to the earthing bar.

1.1.1.4 HV Protective Devices

For oil immersed ring main units the following are applicable.

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Where required on the drawings the following shall be provided:

- Manual operated oil-immersed, fault-making, load-breaking, ON/OFF/EARTH switches for control of the ring circuit.
• Manual operated fault-making, load-breaking, oil-immersed fused-switch for ON/OFF control of an outgoing circuit with trip all phase mechanism and striker pin fuses. Provide an interlock to prevent access to the fuses unless they are isolated from the incoming supply and the outgoing cable.

• Manual operated oil immersed outgoing circuit earthing switch.

• Provide neon "live" indication for ring feeders.

• Provide facilities to padlock switches in the closed, open or earthed positions.

For switchgear utilising SF6 type devices, where shown on the drawings, the following components shall be provided in a single tank charged with sulphur hexafluoride, complying with BS 60376, at a pressure recommended by the manufacturer.

• Two fault-make, load-break, ON/OFF/EARTH switches for control of the ring circuit.

• Outgoing circuit (Tee Off) circuit-breaker.

• Fault making outgoing circuit (Tee Off) earthing switch.

• Emergency trip switch to isolate all HV switchgear.

Where required, high voltage circuit-breakers shall be of type and application as indicated on the schedule or drawings in accordance with BS EN 62271.

Automatic shutters shall be provided to cover high voltage contact spouts when circuit breaker is removed from fixed compartment.

A mechanical indicator shall be provided of contacts open or closed visible through window aperture in circuit breaker enclosure.

Circuit breakers shall be provided with manual trip facilities.

Shunt trip mechanism shall be provided, operating voltage as indicated.

An integral fault making earth switch shall be provided with rated short-time withstand current as indicated for switchboard for circuit earthing and/or busbar earthing as indicated on the drawings.

Facilities shall be provided to padlock breakers and switches in the ON, OFF and EARTHED positions.

The operation of the circuit breaker closing, tripping, interlocking, intertripping, protection devices, indicator lights, remote control, indication and alarm systems shall be satisfactorily tested.

Facilities shall be provided for secondary circuits to be operationally tested with circuit breaker isolated from main circuit.

1.1.1.5 Switch Room

The Electrical Services Contractor shall provide a modular main distribution switchboard, located within the new Switch Room. The Switch Board will provide power supplies to all sub-main and final circuit loads. The Contractor shall provide a 12-way TP&N MCB distribution board, located within the new Switch Room. The distribution board will be designated as “power and lighting” and will, in conjunction with the Switch Board, provide power supplies to all sub-main and final circuit loads, as detailed within the appended drawings.

The Contractor shall provide a “Treatment for Electric Shock Notice” and a schematic drawing indicating the relevant distribution equipment within the Switch Room. The schematic drawing shall indicate the calculated prospective short circuit current, earth
loop impedance, cable sizes, switch and distribution board details, and positions of equipment, measured $I_p$, $Z_e$ and maximum demand values. The schematic drawing shall be framed, glazed and mounted adjacent to the switchgear.

### 1.1.1.6 Standby LV Distribution

A generating set shall be provided to BS 4999, BS 5000, BS ISO 8528, BS EN 60034-22 comprising a diesel engine, direct driven alternator/exciter, cooling system, exhaust system, engine/alternator control panel, a daily service fuel oil tank and engine starting system.

Anti-vibration mounts shall be provided between the base frame and the enclosure floor to eliminate structure borne noise and vibration.

The performance of the engine shall be in accordance with BS ISO 3046. The engine type shall be four stroke and either air cooled / water cooled and turbo-charged or normally aspirated to suit duty.

The fuel oil shall conform to BS 2869 Class A2 and as a minimum the day tank will contain fuel for running set on full load for 6 hours unless otherwise scheduled.

An engine speed governing system shall be provided in accordance with BS ISO 3046 and controls to manually adjust speed of engine ± 5% from nominal speed under all load conditions.

An engine over-speed protection device shall be provided in accordance with BS ISO 3046 incorporated in speed control system.

Cooling systems shall cool the engine when running on continuous full load and on 10% overload for one hour.

A 24 V DC supply shall be provided to start engine from any crankshaft position, by axial type starter motor engaging with flywheel. Ensure starter motor disengages automatically when engine starts or when de-energized.

The battery shall have capacity to crank the engine, when cold, 6 times in succession at $15^\circ$C with 10 seconds between starts.

Battery type shall be low maintenance, sealed, Lead Acid.

Current-limited constant-current/constant-voltage chargers shall be provided in accordance with battery manufacturer's recommendations, with boost and trickle charging as required, and over current and over voltage protection. Earth fault detection and alarm shall be provided where battery and charging system are not connected to earthed system.

Exhaust systems shall be provided in accordance with manufacturer's recommendations and to meet noise limitation requirements. Include exhaust silencer, expansion bellows and all fittings, gaskets, joints and fixings.

Solid state type automatic voltage regulators shall be provided with manual adjustment to set alternator output within 5% of rated voltage.

A schedule of controls and indication devices mounted on the engine/alternator control panel shall be submitted along with the shop drawings and technical information for review and approval by the engineer.

Where indicated on the drawings an automatic transfer switch shall be provided capable of transferring the load automatically onto the generator supply following a power outage,
the transfer switch or switches shall be located either at the location of distribution panels and switchboards or adjacent to the items of plant the generator serves.

The ATS shall incorporate auxiliary contacts for monitoring purposes.

### 1.1.1.7 Uninterruptible Power Supply

Uninterruptible Power Supplies to BS EN 62040: Part 1-1 and BS EN 62040: Part 1-2, shall have rating and configuration as indicated on the Drawings and Schedules.

Cooling fans shall be provided to permit units to operate at full rated load with one fan out of service.

Components to include:

- Transformer–rectifier (to BS EN 60146)
- Bypass system
- Switchgear
- Electrical protection
- Instruments
- Control and indication
- Inverters
- Batteries and chargers

A transformer–rectifier shall be provided in accordance with BS EN 60146.

A continuously rated unit shall be provided to supply full rated input load of the inverter plus maximum battery charging current, with double wound input transformer in the following configurations:

- 6-pulse transformer/rectifier for outputs up to and including 100 kVA
- 12-pulse transformer/rectifier for outputs over 100 kVA

Phase-shifting of input supplies to multi-unit systems shall be incorporated to reduce total harmonic current drawn from mains supply.

Automatic static switch bypass shall be provided to transfer load to bypass supply, without a supply break, when output of inverter deviates from specified limits. Inhibit operation of bypass if inverter output is not in synchronism with bypass supply.

Internal manual bypass shall be incorporated with arrangements for completely isolating the equipment from all supplies for maintenance or provide for connection of external manual bypass supplied and installed by others (refer to drawings for applicability).

DC output protection shall be provided by fuse combination unit to BS EN 60947: Part 3 with fuses to BS 88: Part 1 (BS 60269: Part 1).

AC input circuit-breaker shall be provided to BS EN 60898 or BS EN 60947: Part 2 or provide fuse combination unit to BS EN 60947: Part 3 with fuses to BS 88 Part 1 (BS EN 60269: Part 1).

Flush mounted instruments shall be provided in dust and moisture resistant cases. Analogue instruments shall conform to BS EN 60051: Part 1 and digital instruments to BS EN 60073.

A static inverter shall be provided to supply rated load continuously and 150% rated load for 10 seconds in any period of 15 minutes to BS EN 60146.

Output frequency shall be controlled automatically to enable unit to operate in synchronism with bypass supply but to run independently when bypass supply deviates...
from specified limits of voltage or frequency. Provide manual adjustment of frequency within the range +5% of nominal.

On-load switch disconnector shall be provided at output of converter system. Include double-wound output transformer and filters to reduce the harmonic content of the output voltage waveform to specified limits when supplying rated output to load of indicated characteristics. Comply with BS IEC 60747: Part 1 and BS IEC 60748 for the application of thyristors.

Battery manufacturer’s recommendations shall apply for current limit and fault voltage, with over-current and over-voltage protection.

Earth fault detection and alarm shall be provided where battery and charging system are not connected to earthed system.

### 1.1.1.8 LV Distribution

**LV switchgear**

The LV switchboards shall be constructed to BS EN 60439: Part 1, a type tested assembly and in accordance with the requirements of the Electricity Distribution Directorate’s Regulations for Electrical Installations as currently amended.

Enclosure shall be steel and the assembly construction shall conform to BS EN 62208, with the panel form number indicated. The panel and distribution equipment shall be complete with all necessary cable termination, cable spreader, and so on, to complete and provide power.

All busbars are to be fully rated for Current carrying capacity, Frequency, Fault Level and rated Voltage as detailed on the drawings and/or schedules. Neutral bars are to be fully rated and not ½-sized bars. All bus bars must be insulated with non-hygroscopic insulation.

The complete assembly shall be manufactured by an ASTA certified manufacturer.

Internal Separation to BS EN 60439: Part 1.

The assembly shall protect against direct and indirect contact, with protection maintained after removal or withdrawal of removable or withdrawable parts.

Earth terminal, or for multi-cubicle enclosures a copper earth bar the full length of the enclosure shall be provided, so that exposed conductive parts of the assemble can be connected to the protective conductor. Earth connections shall be made to the assembly without damage to the finish coating. Armouring and metal sheaths of all incoming and outgoing cables, including common and individual glanding plates, shall be bonded to earthing terminal or bar.

Inspection and maintenance of the board will be possible when assembly is in service and under voltage. Space shall be provided between functional unit or group and adjacent functional units or groups. Retainable fastening means shall be provided for parts likely to be removed for maintenance.

Finish and colour shall be as Manufacturer’s standard unless otherwise stated in the schedules. When other than manufacturer’s standard finish is specified, samples for each paint system and for each colour shall be provided.

Type tests shall be undertaken and certificates of verification provided for the following:

- Temperature rise limits (taking account of expected ambient conditions).
- Dielectric properties.
- Short circuit strength.
• Continuity of protective circuit.
• Clearances and creep age distances.
• Mechanical operation.
• Degree of protection.

The following routine tests shall be performed at the works after the panels have been finished and before shipping to site (routine tests to be retaken at site following re-assembly):

• Dielectric test
• Insulation resistance test
• Primary and/or secondary current injection
• Phase rotation
• Operation of protection devices, instruments and measuring devices
• Operation of control and monitoring devices

The Engineer/design team and Client shall be invited to witness these tests at a time convenient to them.

Components of site assemblies shall be part of a proprietary system and type tested as defined above. Install assemblies in accordance with manufacturer’s drawings and instructions.

Site alterations shall not be made unless authorised. Where site modifications to assemblies are authorised, modifications shall comply with the manufacturer's certified drawings and instructions, and with type test certificate obtained for the arrangement of components.

1.1.1.9 LV Switchgear Components / Protective Devices

Battery charger and battery unit

Where required a battery charge and battery unit shall be provided to operate certain equipment upon mains failure, with function, input voltage and frequency as the following schedules or as on drawings.

• DC Output Voltage drop at full load 2%.
• Operating temperature range 10°C to 45°C.
• Charger type Thyristor or Transistor.
• Battery type Nickel Cadmium (maintenance free).
• Enclosure, sheet steel, IP31.
• Corrosion resistant epoxy paint or Manufacturer's standard.
• Colour Manufacturer's standard.

The following facilities shall be provided

• MCB input protection.
• Float charge.
• Battery over discharge protection
• Fuses for battery protection.
• MCB's for outgoing circuits as indicated.
• Automatic selection of boost charge.

The following meters shall be provided

• Battery voltage.
• Charge/discharge current (dual scale for float and boost).

The following lamp indications shall be provided
• Supply on.
• Supply fail (monitor input terminals).
• Float charge.
• Boost charge.
• No charge (when supply is on).
• Battery voltage low.
• Battery voltage high.
• Earth fault on output.

A common alarm shall be provided, connected to operate a relay with shrouded 230 V 3A AC or 0.5 A DC N/O-N/C volt free contacts, closed on any alarm, for remote indication circuit and with the following indicators:

• Supply failed.
• No charge (when supply is on).
• Battery voltage low.
• Battery voltage high.
• Earth fault on output.

1.1.1.10 Air Circuit Breakers

Air circuit breakers (ACB’s) shall comply with BS EN 60947: Part 2, with fixed or withdrawable isolating removable type circuit breakers with provision for safe maintenance. The uninterrupted current rating indicated shall apply when unit is enclosed and in operating environment at rated operational voltage and Utilisation Category shall be B.

Circuit-breaker shall be provided with rated service short-circuit breaking capacity (Ics) and short time withstand current (Icw) equal to or greater than that for the associated switchboard.

A minimum of 3 (unless otherwise detailed or required) N/O-N/C volt free auxiliary contacts shall be provided, rated a minimum 10 A 230 V wired to external terminals within the outgoing cabling section.

Interlocks to prevent movement of the circuit-breaker shall be provided within the housing when in ’closed’ or ’service’ position, with automatic shutters to cover all live contacts when circuit-breaker is isolated, withdrawn or removed from housing.

Facility shall be provided to padlock circuit-breaker in isolated/withdrawn position, and to lock automatic shutters covering live contacts when breaker withdrawn from housing.

1.1.1.11 Moulded Case Circuit Breakers

Moulded case circuit breakers (MCCB’s) shall comply with BS EN 60947: Part 2, with moulded case isolating or fixed type circuit-breakers, as detailed, with provision for safe maintenance. The uninterrupted current rating indicated shall apply when unit is enclosed and in operating environment at rated operational voltage and Utilisation Category shall be B.

Circuit-breaker shall be provided with rated service short-circuit breaking capacity (Ics) and short time withstand current (Icw) equal to or greater than that for the associated switchboard.

Manual closing mechanism and protection shall be provided by combination of adjustable magnetic/thermal compensating devices unless otherwise indicated.

A minimum of 2 (unless otherwise indicated or required) N/O-N/C volt free auxiliary
contacts shall be provided, rated a minimum of 10 A 230 V AC wired to external terminals within outgoing cabling section.

Interlocks shall be provided to prevent movement of circuit breaker within housing when in 'closed' or 'service' position, with automatic shutters to cover all live contacts when circuit breaker is isolated, withdrawn or removed from housing.

Facility shall be provided to padlock circuit breaker in isolated/withdrawn position, and to lock automatic shutters covering live contacts when removed from housing.

1.1.1.12 Air Break Switches

Air break switches shall comply with BS EN 60947: Part 3, with uninterrupted rated duty and Utilisation Category AC 23 B (infrequent operation) unless otherwise indicated, and operational performance not less than requirements of BS EN 60947: Part 3, Table IV.

Fuse switches shall be fitted with cartridge fuse links in accordance with BS 88 (BS EN 60269), removable neutral link in switches controlling circuits with neutral conductor, solid links in isolating switches, and each switch shall be provided with facility to padlock in OFF position.

Withdrawable chassis isolating type switches shall be provided with fully shrouded fixed contacts or insulated cover plates, to prevent accidental contact with live parts.

Switches shall have individual enclosures and earth terminal, meet the degree of protection for the switchboard and operating mechanisms interlinked with access door.

1.1.1.13 Protection Devices and Relays

Protection devices and relays shall comply with BS EN 61810 and BS 5583, and as specified in the Work Sections, on drawings or Schedules.

Units shall be located such that operation may be observed and the devices reset or adjusted without access to the interior of the enclosure.

1.1.1.14 Trip/Close Switches and Control Selector Switches

Units shall comply with BS EN 60947: Part 5-1.

A panel mounted heavy duty, spring return key operated trip/close switch shall; be provided on each circuit-breaker fitted with electrically operated closing mechanism.

Contacts shall have a continuous rating of 10 A minimum at between 30 V to 250 V AC and DC, and make and break duty rating of 30 A at 250 V AC or DC for a minimum period of 3 seconds.

Where remote trip/close control is required, a panel mounted selector switch shall be provided to select circuit-breaker for local or remote operation. Selection of remote or local closing shall not prevent circuit breaker tripping under fault conditions.

1.1.1.15 Control Circuits

Control circuit voltage shall preferably not exceed 110 V AC (55-0-55).

Where control circuits are taken outside the enclosure to remote equipment, 24 V AC shall be used.

For circuit-breaker shunt trip and protective circuits, 30 V DC shall be used, and for integral protective devices 230 V AC, or as otherwise indicated.
Control circuit transformers shall be provided to supply power at voltages to suit control components in accordance with BS EN 61558: Part 2-23, complete with primary and secondary fuses.

1.1.1.16 Motor Starters

Motors rated up to and including 5 HP shall be provided with direct on line starting devices with a current limit of no greater than 5 times the running current.

Motors rated between 5 HP and 20 HP shall be provided with auto star delta type starting devices and shall be arranged to limit the starting current to no more than 2.5 times the rated current.

Motors rated at higher than 20 HP shall be provided with auto transformer type starters, slip ring starters or star delta starters.

Where control of the motor is to be very precise or an energy efficiency design for off-peak loads is to be undertaken the use of variable speed drives shall be employed.

1.1.1.17 Current Transformers

Units shall comply with BS EN 60044: Part 1, with separate current transformers for each protection device and instrumentation. Current transformers shall provide appropriate accuracy and be compatible with protective device characteristics, performance and VA rating required for satisfactory operation of protection devices, instruments and meters indicated.

Current transformers shall be capable of withstanding maximum short time withstand current of value and duration indicated for assembly.

Test links shall be provided in secondary connections of all current transformers to facilitate testing of instruments, meters and protection devices.

1.1.1.18 Instruments and Meters

Units shall comply with BS EN 60051 for voltmeters, ammeters, watt meters, frequency indicators and power factor indicators, and with BS 7856, BS EN 62053: Part 11, BS EN 62053: Part 22, or BS EN 62053: Part 21 for kWh meters, kVA and kW maximum demand meters and polyphase reactive kVA meters and BS EN 62053: Part 23 for KVArh meters.

Wiring to voltmeters and potential coils of watt meters, frequency indicators, power factor indicators and kWh meters, kVA and kW maximum demand meters and polyphase reactive kVA meters shall be protected by separate fuses.

Instruments and meters shall be suitable for flush mounting and type, size and accuracy as drawings or schedules.

All instruments shall be completely segregated in instrument compartments, with panel mounted meters on front of instrument compartment.

1.1.1.19 Indicator Lights

Units shall comply with BS EN 842 and BS EN 60947: Part 5-1.

Lamps shall be of same type throughout, with lamp test facility, and interchangeable indicators for respective units.
An integral double wound transformer shall be provided for each lamp unit on AC indicator circuits and an integral ballast resistor for each lamp unit on DC indicator circuits.

1.1.1.20 Instrument and Control Wiring

All instrument and control wiring shall be either single core insulated cable contained within plastic panel wire way or double insulated cabling installed in a harness.

Each end of each wire shall be identified with a unique number using colour coded 'O' ring markers. Fit lugs at termination points.

All wiring shall be neatly arranged, securely fixed, and where appropriate, protected by cartridge fuses complying with BS 88 (BS EN 60269).

Motor control centre, starter and control panel wiring, shall be segregated from power circuits and contained within plastic wire-ways or in a harness.

Each end of each wire shall be identified with a unique number using colour coded 'O' ring markers, with lugs at termination points. All wiring shall be neatly arranged, securely fixed and, where appropriate, protected by cartridge fuses complying to BS 88 (BS EN 60269).

1.1.1.21 Distribution Boards

Units shall comply with BS EN 60439: Part 1 and BS EN 60439: Part 3, as appropriate. Enclosure shall be steel, with hinged lockable cover, internal separation Form 1, degree of protection IP31, unless otherwise indicated. Each distribution board shall be fitted with an isolating switch, size as shown on the drawings.

Busbars shall be installed in same position relative to their fuse carriers or miniature circuit breakers (MCBs) for each pole. In TPN distribution boards, neutral busbars shall be supplied with one outgoing terminal for each outgoing circuit.

Neutral shall be rated as phase conductor.

A multi terminal earthing bar shall be provided for circuit protective conductors for both insulated and metal cased boards, with one terminal for each outgoing circuit, connected directly to earthing terminal without dependence on exposed conductive parts of enclosure.

Each fuse way and MCB way shall be identified by numbering. Each terminal on neutral busbar and earthing bar shall be identified with its respective fuse way or MCB way.

Durable, printed circuit identification chart shall be provided inside enclosure.

Finish and colour shall be as manufacturer's standard unless otherwise stated.

Spare ways shall be provided, 20% or as indicated. Where specific ratings are indicated, fuses or MCBs, shall be incorporated, or ways shall be left blank complete with blanking covers for future additions.

Single phase consumer type units shall comply with BS EN 60439: Part 3. Consumer units shall have minimum degree of protection in accordance with BS EN 60947: Part 1, IP31. Fuses or miniature circuit breakers and means of isolation shall be provided as indicated.

Miniature circuit breakers (MCBs) shall conform to BS EN 60898.
Miniature circuit breakers shall be provided in accordance with BS EN 60898, and voltage and current ratings, and type, according to instantaneous tripping current, rated braking capacity and frequency, as drawings or schedules.

Residual current devices (earth leakage devices) shall comply with BS EN 61008. Supply devices with rated voltage, rated current, rated tripping current, rated tripping time and rated breaking capacity as indicated in the accompanying drawings and specifications.

Combined earth leakage/over current operated circuit-breakers shall comply with BS EN 61009.

Where earth leakage current monitors are used these shall comply with BS EN 62020.

Switchgear and distribution boards shall be provided with facilities to terminate size, number and type of cable indicated. Where necessary fabricated steel extension boxes shall be used for glanding large and multiple cables.

Non ferrous metal glanding plates shall be provided for single core cable terminations.

Rail mounted moulded terminal blocks shall be provided with fully shrouded connectors, segregation plates, and end clamps. Insulating material shall be suitable for maximum operating temperature of conductors.

Connectors shall be provided to clamp conductors between metal surfaces. Clamping screws shall not make direct contact with conductors. Conductors shall maintain sufficient contact pressure to ensure negligible impedance. Metal in contact with conductors shall be 85% copper alloy and screws shall be of metal electrolytically compatible with copper alloy.

1.1.1.22 Power Factor Correction

Power factor correction equipment shall be suitable for operation from the supply voltage and frequency, including the tolerances specified elsewhere.

Power factor correction equipment shall be provided to correct the power factor to the value specified elsewhere but as a minimum in accordance with the Electricity Distribution Directorate’s Regulations for Electrical Installations as currently amended.

Power factor correction equipment intended to be applied centrally or to specific groups of motors shall comprise a sufficient number of capacitor units to make up the specified capacitance, accommodated in a suitable cabinet or in a series of modular cubicles assembled together to form a composite unit, together with a control relay, switching equipment, protective fuses and means of isolation, all assembled and connected to as to control automatically the switching ‘on’ and ‘off’ of the capacitors in response to changes in the load power factor.

Each capacitor stage shall be protected by BS EN 60269 fuses and be switched by a separate, block type contactor rated for capacitor switching duty (BS EN 60947: Part 4-1 AC-6b).

Capacitors shall be self-healing type to IEC 60831: Part 1. Each capacitor shall have overpressure operated disconnect fuse elements, in addition to over current protection.

Capacitors shall be provided with discharge resistors to achieve full discharge within 60 seconds of disconnection. Capacitors shall have low loss per kVAR and be rated for a line current not less than 1.3 times the rated current. Means shall be provided to identify a failed capacitor or bank of capacitors. Units of equal capacitance shall be interchangeable.
Detuned 3 phase reactors, iron cored and with copper windings shall be connected in series with each capacitor stage for harmonic current suppression.

The control relay shall be suitable for operation from the existing current transformer(s) installed for the purpose in the main low-voltage switchboard as required by the P.F.C. manufacturer.

A microprocessor based reactive power controller shall be provided to control switching of the capacitor banks and allow rotation of use of the banks to uniformly distribute usage.

Shrouding and large, clearly visible warning labels shall be provided within the enclosure to warn personnel of the need to discharge the equipment prior to any work.

### 1.1.1.23 HV/LV Cabling and Busbar

Low-voltage cables shall have a voltage designation of 450 V/750 V for harmonised types and 600 V/1,000 V for armoured cables. Reduced neutral conductors in multiword cables are not acceptable. Conductors shall be copper unless otherwise specified. Labels on cable drums shall indicate the manufacturers name, size, description, BS number, classification, length, grade and date of manufacture.

All cable types shall be certified and marked in accordance with the British Approvals Service for Electric Cables (BASEC) Regulations or the equivalent CENELEC harmonised cable certification marking.

Copies of the manufacturer’s cable test certificates shall be included in the operating and maintenance manual.

Where conductor sizes are not indicated in the specification and/or the associated drawing(s) they shall be selected in accordance with BS 7671 for the current rating required by the circuit loading, the type of cable, the ambient temperature, grouping, the conditions of installation and the maximum voltage drop permissible.

LSF insulated cables shall be 450 V/750 V grade to BS 7211 (where applicable). PVC insulated cables shall be 450 V/750 V grade to BS 6004 (where applicable).

For cables rated up to 11 kV, Cross-linked polyethylene (XLPE) cables shall be 6,350 V/11,000 V grade to BS 6633, with copper conductors.

The conductors shall be stranded plain annealed copper Class 2 complying with BS EN 60228. The conductor insulation shall be cross-linked polyethylene, with easy-peel extruded semi-conducting screen, copper tape screen and at least two layers of suitable bedding tape, to give a uniform thickness to armoured cables. Inner sheath shall be extruded PVC Type 9 to BS EN 50363.

The armour for multi-core cables shall consist of a single layer of galvanised steel wire complying with BS EN 10257: Part 1. The outer serving sheath shall be a layer of red LSF complying with the requirements of BS 6724 Type 9 flame retardant. The sheath shall be embossed with the manufacturer’s details as specified in the British Standard.

Single core cables shall have non-magnetic armour such as aluminium wire or strip.

For cables rated up to 1,000 V, cross linked polyethylene (XLPE) cables shall be 600 V/1,000 V grade to BS 5467, with copper conductors.

The conductors shall be stranded plain annealed copper class 2, complying with BS EN 60228. The conductor insulation shall be XLPE, identified in accordance with Table 51 A of BS 7671.
The armouring for multi-core cables shall consist of a single layer of galvanised steel wires complying with BS EN 10257: Part 1. Single core cables shall have non-magnetic armour, such as aluminium wire or strip.

The outer sheath shall be a layer of black LSF complying with the requirements of BS 6724, Type 9 flame retardant. The sheath shall be embossed with the manufacturers details as specified in the British Standard.

Any cable joints shall be undertaken following a request and approval from the engineer in writing.

All switchboards shall have top cable entry via bolted gland plates.

Cables will not be relocated/rerouted without written approval from the Engineer.

1.1.1.24 **Fire Performance Cabling**

Light duty mineral cables shall comply with BS EN 60702: Parts 1 and 2.

All conductors shall be copper unless otherwise indicated. All cables shall have an outer sheath as indicated. 500 V light duty cables shall be used for sizes up to 2.5 mm², 750 V heavy duty cables for sizes over 2.5 mm² to 25 mm² and 750 V heavy duty single core cables for over 25 mm² unless otherwise indicated. Outer sheath colours shall be:-

- Red - Fire Alarms
- White - Emergency Lighting
- Orange - Other Services

Heavy duty mineral cables shall comply with BS EN 60702: Part 1, Section 15 and the outer covering shall be halogen free material to BS 60702: Part 1, Section 15.

Fire performance shall be in accordance with BS 5839: Part 1 and the NFPA equivalent.

Soft skinned fire rated cables shall conform to BS 6387 Category CW&Z

1.1.1.25 **Communications Cabling (copper and fibre)**

Multimode fibres shall comply with EIA/TIA 492 specifications and OM3 fibre specification as in ISO/IEC IS 11801 standard.

Single mode fibre shall comply with EIA/TIA 455 and BS EN 60793 test methods for required attributes.

The 4 pair UTP cable shall be UL and c(UL) Listed Type CMP (plenum) or CM (non-plenum), or LS0H.

All 4 pair Category 6 cables shall conform to TIA/EIA-568B, IS11801, and BS EN 50173.

For slow speed applications 4 pair Category 3 cabling shall be used.

The structured cabling system when used in conjunction with equipment meeting the appropriate ECMA standards shall be fully compliant with emission standards BS EN 55022, BS EN 61000:Part 6-3 and BS EN 61000: Part 6-4.

The structured cabling system when used in conjunction with equipment meeting the appropriate ECMA standards shall be fully compliant with immunity standards BS EN 61000: Part 6-1, BS EN 55024 and BS EN 61000: Part 6-2.
1.1.1.26 Controls Cabling

All conductors shall be copper unless otherwise indicated.

All cables shall conform to the relevant following standards of BS 5308, BS 5467, BS 6346, BS 6724, BS 7629, BS 7846, BS 7870, BS EN 50288: Part 7 as appropriate.

1.1.1.27 Busbar Trunking System

Busbar trunking systems shall conform to BS 60529 and BS EN 60439 and shall be in accordance with the Electricity Distribution Directorates’ rules and regulations. The systems shall comprise a sheet metal enclosure, copper busbars and be complete with busbar supports, expansion joints, thrust blocks, fire resisting barriers, and cable terminations.

Bus bars shall be cold rolled copper bars of 98% conductivity. Joints shall be coated with a minimum of 0.01 mm silver.

The bus bar shall be fully tested and received approval from the ASTA certification body. Tap-off units shall incorporate H.R.C. fuses or MCCB’s.

The enclosure shall be continuously earthed throughout its length and each joint shall be bonded by copper links.

Bus bar trunking shall fully comply with BS. EN 60439: Part 2 and shall be type tested in accordance with BS EN 60439: Part 2 to establish the short circuit withstand ratings. In the case of short-time rating the specified current is applied for the quoted time.

The IP rating of the trunking shall be as per the drawings and particular specification.

Bus duct shall be low reactance type of voltage and rating as shown and as specified hereinafter. Neutral, where required, shall be fully capacity. Bus duct shall be of ventilated type unless noted otherwise. All bus ducts, joints, tap-off positions and plug units, and so on, shall be protected from sprinklers (IP54) throughout.

Neutral conductors shall be fully rated with an option of 200% rating where required by high harmonic content loads.

Busbars shall be provided with an integral earth conductor CPC bar within the enclosure, rated at least 50% size.

Where required cast resin busbars may be used either for high ingress protection requirements or for the distribution of fire rated supplies.

Where this is required the copper busbar shall be embedded in an enclosure of a non flammable, self-extinguishing and homogeneous insulation mix based on epoxy cast-resin with mineral fillers ensuring high mechanical strength and chemical withstand.

Minimum IP rating for cast resin busbar shall be IP 67.

The busbar resin shall be made from non-flammable, self-extinguishing insulation to BS EN 60332 and DIN 4102 Part 1.

Electrical continuity E30 shall be to DIN 4102 Part 12.

Fire-proof wall bushings, A60, H60, S60 to S180 shall be to DIN4102 Part 9, fire resistant to IEC 60331, and code EEX m II T5 certificate to BS EN 60079: Part 18.

1.1.1.28 Cable Support Systems

All cables shall be supported throughout their length using conduit, trunking and
enclosures, cable tray, cable racking, special support systems, cleared or clipped fixing direct to building fabric, or aerial catenary suspension systems, as required.

Cable support systems shall allow for spacing in accordance with BS 7671 for the design current of the cable.

Cable trays, ladders and baskets shall conform to BS EN 61537 and BS 6946 and shall be constructed of hot rolled steel galvanized after manufacture to BS EN ISO 1461; or bending and profiling quality hot dipped galvanized steel to BS EN 10327 or BS EN 10143.

All continuous runs of cable support systems shall be electrically continuous.

1.1.1.29 Cable Conduit and Trunking

Conduit systems and fittings used for the installation of electrical services shall comply with BS EN 61386 and BS EN 856 as appropriate.

Conduit shall be from one manufacturer throughout, with fittings to match conduit grade and finish.

Temperature classification of conduits shall be -5+60°C.

Resistance against ingress of water and solid foreign bodies shall be rated to BS EN 60529 with a minimum classification of minimum IP 31 for indoor use, to minimum IP 65 for exterior.

Standard trunking systems and fittings used for the installation of electrical services shall comply with BS EN 856 and BS EN 50085. Trunking of each type shall be from one manufacturer.

Material for steel trunking shall be to BS EN 50085, and partitions and covers shall be of the same material as trunking, as follows:

- Class 2: Electroplated zinc having a minimum thickness of zinc coating of 0.0012 mm inside and outside with additional coating of stoved or air drying paint, applied at least to the external surface.
- Class 3: Hot dip zinc coated steel to BS EN 10327 or BS EN 10143 and BS EN 10326.

Flanges shall be provided for connection of flush floor trunking to vertical trunking to maintain the cross sectional area of compartments with 50 mm minimum radius.

Under floor trunking shall be to BS 4678: Part 2, gauge of metal to Table 1 BS 4678, degree of protection Class 3.

All sheet steel materials shall be hot dipped galvanized.

Service outlet boxes and junction boxes shall be constructed from sheet steel with same finish as trunking. Continuity and segregation of compartments shall be maintained through boxes, with flyovers where necessary. Service outlet boxes shall be provided with separate and segregated access to outlets associated with each wiring compartment. Cable guard or grommet shall be provided to each section. Spigots or adaptors shall be incorporated on boxes for connection to trunking or conduit as appropriate. Frames shall be adjustable on each corner, and lids recessed as indicated. Frame and lids for service outlet boxes and junction boxes, shall be suitable to accept type of floor covering specified.
Surface trunking constructed of insulating materials shall conform to BS 4678: Part 4. Material as indicated with temperature tolerances BS 4678: Part 4, Table 1 (-5+60°C).

Proprietary suspension systems shall be provided comprising channel sections with return lips and compatible fixing accessories of materials to BS EN 10162 or BS EN 10210 and/or slotted angles to BS 4345.

All steel components such as studding, bolts and steel screws, bolts, nuts and washers shall be either cadmium plated and passivated or zinc electroplated after manufacture. Metal fixing components likely to deteriorate and/or cause damage through electrolytic action shall not be used.

All continuous runs of cable containment systems shall be electrically continuous.

1.1.2 Electrical Accessories

1.1.2.1 Common Requirements

Accessories shall be as detailed in the particular specifications and shown on drawings in accordance with the following standards:

- Enclosure box to BS 4662 for recessed
- Enclosure box to BS 5733 for surface

Degree of protection shall be (to BS EN 60529):

- Minimum of IP20 Interior
- Minimum of IP54 Exterior

Hazardous area classification shall be to BS EN 60079: Part 14, BS EN 60079: Part 1 and intrinsic safety to BS EN 50020.

Degree of mechanical protection shall be to BS EN 62262.

Cover plates shall be overlapping unless otherwise specified.

Enclosure material and finish shall match conduit system. Enclosures shall be recessed or surface as specified elsewhere.

Accessories shall sustain high temperature and of polycarbonate/thermoset material which shall not melt or change in colour with heat/change in climate conditions.

1.1.2.2 Interior Lighting Switches

Units shall satisfy the requirements of BS EN 60669: Part 1.

Switches shall incorporate rocker bars unless otherwise specified. For emergency lighting a secret key switch shall be used with rocker bars as other switches in that area. If dimmers and/or press switches are shown on drawings then they shall be of the same rocker bar pattern as the switches in that area.

Rating of all the switches shall be 15 A. Mounting shall be on an adjustable steel grid. All switches shall have a snap action micro gap mechanism. Pole configurations shall be as indicated on the drawings.

Earthing terminal shall be integral within switch box and on the switch plate, and where grid switches are used, blank inserts shall be provided in all spare ways.

Dimmers shall be rocker or rotary type.
Switches shall be grid type with 50% de-rating factor applied for the fluorescent lighting loads.

1.1.2.3 Pull Cord Switches

Units shall satisfy the requirements of BS EN 60669: Part 1.

Rating of all the switches shall be 16 A for lighting circuits and 40 A to 45 A for showers, fans etc as specified. Mounting shall be surface. All switches shall have a snap action micro gap mechanism.

Earthing terminal shall be integral within switch box and on the switch plate.

1.1.2.4 Exterior Lighting Switches

Units shall satisfy the requirements of BS EN 60669: Part 1.

Switch type shall be either rocker bar with sealed-in plastic membrane or rotary disc or lever operating through sealing gland. Rating of all switches shall be 15 A. Action shall be two position, unless otherwise stated. Enclosure pattern shall be weatherproof and shall be surface, unless otherwise stated. Enclosure material shall be galvanized cast iron or impact resistant moulded plastic.

Earthing terminal shall be integral within switch box and on the switch plate.

1.1.2.5 Time Switches

Units shall satisfy the requirements of BS EN 60730: Part 2-7.

Time switch type shall be quartz stabilized motor with 30-hour spring reserve or quartz stabilized solid state with a minimum of 50 hour nickel cadmium battery backup unless otherwise specified.

Enclosure shall be dustproof sheet steel or impact resistant moulded plastic with viewing panel and arranged for conduit entry, unless otherwise indicated.

1.1.2.6 Luminaire Connectors

Units shall be load-carrying captive cord grip type plug/socket, with clip on cover, to BS 5733 or BS 546 (3 or 4 pin as appropriate).

Load carrying capacity shall match connected luminaire.

1.1.2.7 Isolating Switches

Isolating switches shall be provided for fixed appliances, with utilization category and making capacity as indicated, to satisfy the requirements of BS EN 60669: Part 1 or BS EN 60947: Part 3.

Mounting shall be on an adjustable steel grid, with engraved front plate to indicate equipment served by name and circuit designation.

Earthing terminal shall be integral within switch box.

1.1.2.8 Fuse connection units

Units shall satisfy the requirements of BS 1363: Part 4.

Engraved front plate shall indicate equipment served, with pole configuration DP switched or unswitched as shown on the drawings.
Fuses shall be BS 1362 sized as indicated and to suit appliances. Configurations of Neon indicators and cord outlets or grips shall be as detailed elsewhere.

1.1.2.9 **Socket Outlets**

Units shall satisfy the requirements of BS 1363 for general purpose domestic/commercial type outlets and industrial socket outlets to BS EN 60309: Part 1.

Socket outlets shall be single or twin and switched or unswitched as shown on drawings. The rating shall be 13 A or as shown on drawings.

1.1.2.10 **Cooker Control Unit**

Cooker unit shall satisfy the requirements of BS 4177, with integral 13 A switched socket outlet and pilot light and with a pole configuration of DP switched. The rating shall be 45 A. This shall be protected by 30 mA ELCB.

1.1.2.11 **Flexible Cord Outlets**

Units shall satisfy the requirements of BS 5733 and BS EN 61058: Part 2-1.

Engraved front plate shall indicate equipment served. Rating shall be 20 A for all outlets except cooker and for cooker outlets 45 A. Pole configuration shall be DP & E.

1.1.2.12 **Telephone/IT Outlet Sockets**

Units shall satisfy the requirements of BS 6312: Part 2 or RJ 45, LJU and the requirements of the local company/provider regulations.

Size shall be standard unless otherwise indicated. Circuit configurations shall be as indicated on drawings. Connections shall be insulation displacement type unless otherwise indicated.

1.1.2.13 **Aerial Sockets**

Units to satisfy the requirements of BS 3041: Part 2

Circuit configurations (single or dual or TV and/or FM) shall be as indicated on drawings. Connections shall be insulation displacement type unless otherwise indicated.

1.1.2.14 **Low Voltage Isolating Transformer**

Units shall satisfy the requirements of BS EN 61558, BS EN 61558: Part 2-15 (in medical locations).

The configuration shall be single phase, double wound, with rating – input 230 V and an output (kVA) as indicated elsewhere, and as in the following Table.

<table>
<thead>
<tr>
<th>Type</th>
<th>Output Voltage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>10 V</td>
<td>For power tools in plant rooms with plug and socket to BS EN 60309: Part 2</td>
</tr>
<tr>
<td>V2</td>
<td>24 V</td>
<td>For portable lights in plant rooms</td>
</tr>
<tr>
<td>V3</td>
<td>110 V/24 V dual</td>
<td>For power tools and portable lights in plant rooms</td>
</tr>
</tbody>
</table>

1.1.2.15 **Shaver Points**

Shaver points shall be provided, internally switched by plug insertion in accordance with BS 4573, BS EN 61558: Part 2-9, and as per Electricity Distribution Directorate rules and
regulations, and with engraved input and output voltages and 'SHAVERS ONLY', and of rating 20 VA.

Shaver points shall consist of double wound single phase transformer 230 V/230 V and 110 V to BS EN 61558, with Internal overload protection.

Samples of plate finishes shall be provided for decorative/front of house areas.

1.1.2.16 Ceiling Fans

All ceiling fans shall comply with the IEE Regulations, and in particular, with the requirements for earthing and bonding. All ceiling fans shall be provided with safety steel wire.

1.1.3 Lighting and Emergency Lighting

1.1.3.1 Luminaire Construction

The following classifications of general luminaries shall conform to BS 4533, BS EN 60598 and IEC 60598:

- General luminaries
- Recessed luminaries
- Street Lighting
- Floodlighting
- Luminaries with transformers
- Air handling luminaries
- Emergency luminaries (also BS 5266, BS EN 60598: Part 2-22, BS EN 1838, ICEL 1003 and the requirements of NFPA 101)
- Underwater luminaries (fittings to BS EN 60598 and enclosures to BS EN 60529 (minimum: IPX8), control gear to be via SELV transformers.
- Fluorescent lamps in accordance with BS EN 60081.
- Starters for Fluorescent lamps to BS EN 60155.

Track lighting systems shall comply with BS 4533, BS EN 60570.

Photometric measurements for luminaries shall be derived in accordance with BS EN 13032.

EMC emissions and EMC immunity of light fittings shall comply with the requirements of BS EN 55015, BS EN 61000 and BS EN 61547 respectively.

Disturbance in the supply system shall be governed by EN 60555 and BS EN 61000.

Columns for the use in external lighting applications shall be manufactured from steel to BS EN 40, hot dipped galvanised to BS EN ISO 1461 or of aluminium and roots are to be bitumen coated. Cut-outs utilised for external lighting columns and similar items shall be to BS 7654.

Where high voltage lighting systems have been used such as neon or cold cathode, a means of isolation shall be provided for use by the fire service in the event of an emergency. This fireman's switch shall be located at high level at the entrance to the premises.

1.1.3.2 Control Gear

The following table indicates the type of control gear and its corresponding code:
Table 3 Device Type, Fitting and Applicable Standards

<table>
<thead>
<tr>
<th>Device Type</th>
<th>Fitting Type</th>
<th>Applicable Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ballasts</td>
<td>For Fluorescent</td>
<td>BS EN 60921</td>
</tr>
<tr>
<td></td>
<td>For Discharge</td>
<td>BS EN 60923</td>
</tr>
<tr>
<td></td>
<td>For DC electronic Fluorescent</td>
<td>BS EN 60925</td>
</tr>
<tr>
<td></td>
<td>For AC electronic Fluorescent</td>
<td>BS EN 60929</td>
</tr>
<tr>
<td>Transformers</td>
<td>Electronic Step-down</td>
<td>BS EN 61047</td>
</tr>
<tr>
<td></td>
<td>SELV transformers</td>
<td>BS EN 61558</td>
</tr>
<tr>
<td>Starters and Ignitions</td>
<td>Electronic Starters</td>
<td>BS EN 60927</td>
</tr>
<tr>
<td>Capacitors</td>
<td>Capacitor used for lamp circuits</td>
<td>BS EN 60149</td>
</tr>
</tbody>
</table>

1.1.3.4 Luminaire Bodies

Luminaire body and diffuser systems shall be constructed to BS EN 60529 (IEC 60529) Classification of Degrees of Protection by enclosures with respect to the ingress of dust and water.

Additional requirements in terms of impact resistance shall be in accordance with BS EN 62262.

Fire retardant housings to emergency escape luminaries shall comply with EN 60598: Part 2-22.

1.1.3.5 Luminaires for Hazardous Environments

Hazardous areas are classified into zones according to the probability of the presence of flammable atmospheres as outlined in BS EN 60079 for gases and BS EN 61241 for dusts.

Table 4 Classification of hazardous environments

<table>
<thead>
<tr>
<th>Zone Classification</th>
<th>Applicable Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 0 (gases) &amp; Zone 20 (dusts)</td>
<td>Area in which explosive mixture is continuously present or present for long periods.</td>
</tr>
<tr>
<td>Zone 1 (gases) &amp; Zone 21 (dusts)</td>
<td>Area in which explosive mixture is likely to occur in normal operation.</td>
</tr>
<tr>
<td>Zone 2 (gases) &amp; Zone 22 (dusts)</td>
<td>Area in which explosive mixture is unlikely to occur in normal operation and if it occurs it will exist only for a short time.</td>
</tr>
</tbody>
</table>

Gases and vapours are classified into Groups as outlined in BS EN 60079. Guidance on requirements for combustible dusts is given in BS EN 61241 and BS EN 50281. Requirements for apparatus for use in the presence of combustible dusts are given in BS EN 50281.

The combination of the hazardous zone and the classification, the gas group or dust classification, temperature classification and environmental conditions, determines the protection requirements and hence the type of electrical installation that is necessary to be installed. Protection requirements are detailed in the British Standards.

Equipment shall be selected for the type of protection that is required and shall comply with relevant British Standards.

1.1.3.6 Central Battery Lighting System

The MEP Contractor shall ensure that the Emergency Lighting System and all of its components are be manufactured by an ISO 9001/9002 certified company to comply with BS 5266, BS EN 1838, EN 50171, EN 50172 and the local Civil Defence requirements.
The systems shall consist of the following components:

- Central Battery Unit Cabinet
- Full Wave Controlled Thyristor/Diode Bridge rectifier
- Charger and control systems
- Automatic changeover contactors (BS 764)
- Inverter (less than 3% harmonic distortion into linear load)
- Integral display panel
- Batteries (integral to CBU or in adjacent cabinet or open racks dependent upon design)
- Sub circuit monitoring
- Central control and monitoring PC (to latest standards)

Final details of the emergency lighting central battery system (where applicable), shall comply with the particular specification, schedules of equipment and detailed design drawings).

1.1.4 Fire Safety

1.1.4.1 Fire Detection and Alarm Systems

Fire detection and alarm systems shall be provided in accordance with BS 5839, BS EN 54, NFPA 72 and the requirements of the Civil Defence Authority.

The power supply shall normally be 24 V DC derived from the mains via bridge rectifier/transformer equipment, but in the event of a mains failure the system shall operate from a nickel cadmium battery system for a minimum of 24 hours, after which sufficient capacity should remain in the batteries to operate the system during a full fire condition for a further period of 3 hours.

The requirements of the power supply equipment shall be in accordance with the requirements of BS EN 54: Part 4.

Fire alarms shall be inspected and tested in accordance with the manufacturer’s recommendations at the end of installation and prior to handover. The inspection and testing shall be witnessed by the Engineer. The Engineer must be given at least 2 weeks notice prior to testing. The Engineer may wish to invite others to witness the testing. Inspection and test results will be documented and submitted to the Engineer for approval.

1.1.4.2 Basic Components and Wiring

Basic components and wiring shall comply with the standards listed in Table 5.

<table>
<thead>
<tr>
<th>Component</th>
<th>Applicable Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point type (rate of rise) heat detector</td>
<td>BS EN 54: Part 5</td>
</tr>
<tr>
<td>Point type (fixed temp) heat detector</td>
<td>BS EN 54: Part 8</td>
</tr>
<tr>
<td>Point type smoke detectors</td>
<td>BS EN 54: Part 7</td>
</tr>
<tr>
<td>Beam detectors</td>
<td>BS 5839: Part 5</td>
</tr>
<tr>
<td>Flame detectors</td>
<td>BS EN 54: Part 10</td>
</tr>
<tr>
<td>Manual call points</td>
<td>BS EN 54: Part 11</td>
</tr>
<tr>
<td>Sounders</td>
<td>BS EN 54: Part 3</td>
</tr>
<tr>
<td>Components for gas extinguishing systems</td>
<td>EN 12094: Part 1</td>
</tr>
<tr>
<td>Mineral insulated copper covered cable (MICC)</td>
<td>BS EN 60702</td>
</tr>
<tr>
<td>Cables to maintain circuit integrity under fire conditions</td>
<td>BS 6387, meeting at least the requirements for categorisation as AWS or SWX</td>
</tr>
</tbody>
</table>
1.1.4.3 Fire Alarm Interfaces

Fire alarm interfaces shall be provided as detailed in the particular specifications and on the drawings to operate third-party equipment or receive information from third-party equipment where appropriate.

The purpose of the interface shall be either to operate or cease operation of items of plant and equipment as required by the cause and effect strategy or to cause the fire detection and alarm system to raise a warning or alarm status as required.

Interfaces may be included for the following systems (non-exhaustive list):

- Air handling units
- BMS
- Elevators, escalators or travellators
- Fans
- Shut off valves
- Smoke dampers
- Doors
- Smoke curtains
- Gas monitoring systems

1.1.4.4 Voice Evacuation and PA Systems

Where indicated on the drawings and in the particular specification and in accordance with the requirements of the Civil Defence Authority, fire alarm public address and voice alarms, shall be provided, which systems shall comply with the requirements of BS EN 60849, BS EN 54: Part 2 and 4 and BS 5839: Part 8 and the requirements of NFPA 72.

1.1.4.5 Specialist Engagement

A specialist shall supply, install, test, commission and provide maintenance during the defects liability period.

1.1.5 Engineering Safety

1.1.5.1 Electric Shock Protection

Electric shock protection shall be in accordance with the requirements of BS 7671 and the Electricity Directorate: Regulations for Electrical Installations.

1.1.5.2 Earthing and Bonding

Earthing and bonding of the electrical services installation shall comply with the following British Standards and Codes of Practice:

- BS 2754 – Construction of electrical equipment for protection against electric shock.
- BS EN 62305 – Protection against lightning.
- BS 7430 – Code of Practice for earthing.
- BS 7671 – Requirements for electrical installations.

Where pipes etc are to be bonded, the cable shall be connected to an adjustable metal clamp complying with BS 951 for use with variable sizes of water and/or gas pipe.

Approved warning labels shall be fixed to each earth termination or bonding connection to structural steel, water or gas pipes etc, durably marked with the words ‘Safety Electrical Connections – Do Not Remove’.
Where metal conduit, trunking, cable sheaths and/or armouring is employed as part of the earthing system, all joints, terminations and connections shall be constructed to afford a low impedance path for fault currents. All joints and connections shall be suitably protected to prevent deterioration caused by bi-metallic or other corrosion. The cross sectional area of the material shall comply with the requirements of BS 7671.

1.1.5.3 Lightning Protection

Where demonstrated by the results of calculation, the structure shall be protected by a lightning protection system in accordance with the requirements of BS EN 62305.

The system shall comprise an air termination(s), down conductor(s), testing joint(s), earth termination(s) and earth electrode(s). Steel reinforcing in columns shall not be used as a down conductor unless their continuity and current carrying capacity is verified and the reinforced connections are welded and independently verified all to the approval of the Engineer.

The materials for the component parts of the lightning protective system shall be those detailed in BS EN 62305 and BS EN 50164.

1.1.5.4 Cathodic Protection

Where indicated in the particular specification and on the drawings cathodic protection systems shall be provided to protect the reinforcement within the building structure in accordance with BS EN 12696.

1.1.5.5 Facilities for the Disabled

Facilities for the disabled shall be provided in accordance with the requirements of BS 8300 where indicated in the drawings and accompanying particular specification.

1.1.5.6 Electromagnetic Compatibility

Generally all products to be utilised within the systems proposed for installation shall conform to the requirements of BS EN 61000/IEC 61000 with respect to electromagnetic compatibility.

Power transformers shall comply with the requirements of BS EN 62041.

Radio and TV systems shall conform to BS EN 60728.

UPS systems shall comply with the requirements of BS EN 62040: Part 2 with respect to EMC requirements.

Consideration shall be given to PD 1001 with respect to electromagnetic compatibility for structured cabling systems.

1.1.5.7 Harmonic Monitoring and Power Conditioning

Where included within the particular design specification and drawings, harmonic filtering equipment and monitoring equipment shall be provided.

Any monitoring and conditioning equipment shall conform to the requirements of EN 61000 (relevant parts) and IEEE 519.

The system may consist of active or passive equipment, dependent upon the application and type of installation being served and this will be addressed within the particular design.
1.1.5.8 **Cable Certification Marking and Terminal Identification**

Cables shall have CENELEC cable certification marking or if included in British Approvals Service for Cables (BASEC) in accordance with BASEC regulations.

All cables, other than final sub-circuit wiring enclosed in conduits or trunking shall be provided, with labels fixed at each end of cable either side of wall and floor penetrations at approximately 12 m intervals at convenient inspection points by means of non-releasable plastic straps, minimum width 4 mm. Labels shall show the reference number of cables.

Switchgear and control gear element terminals shall be marked in accordance with BS 5472 (EN 50005) and BS 6272 (EN 50042). A unique reference shall identify each element in the switchgear or control gear, marked on or adjacent to each element. Each terminal shall be identified 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.

Adjacent to terminals, lettered or numbered ferrules or sleeves to BS 3858 shall be used to mark each auxiliary conductor or control cable core 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. Main circuit conductors shall be identified in accordance with BS 7671 (IEE Wiring Regulations). All identification of terminals and conductors shall be recorded and included on record drawings and in operation and maintenance documentation.

1.1.6 **Security and Access Control**

1.1.6.1 **Intruder Detection System**

Where indicated in the drawings and specification, an intruder detection system shall be provided in accordance with BS EN 50131: Part 1.

Continuous monitoring of the system shall be performed by the alarm control panel in the set and un-set mode of operation. The requirement for automatic police response shall be as per the particular project requirements.

Requirements for integration with other alarm systems and security systems shall be in accordance with the requirements of BS 8418. Integration with the CCTV system shall be as BS 8418.

The control panel shall be provided with integral battery backup for a duration as indicated in the standard, dependent upon the classification of the system. The power supply shall be in accordance with BS EN 50131: Part 6.


1.1.6.2 **Basic Components and Wiring**

Basic components and wiring shall comply with the standards as used in Table 6 below:
## Table 6 Components and Applicable Standards

<table>
<thead>
<tr>
<th>Component</th>
<th>Applicable Standard</th>
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<tbody>
<tr>
<td>Acoustic detectors</td>
<td>BS 4737: Part 3.6</td>
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<tr>
<td>Beam interruption detectors</td>
<td>BS 4737: Part 3.12</td>
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<tr>
<td>Captive proximity detectors</td>
<td>BS 4737: Part 3.13</td>
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<td>Deliberately operated devices</td>
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<td>Passive infra red detectors</td>
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<td>BS 4737: Part 3.5</td>
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<td>Vibration detectors</td>
<td>BS 4737: Part 3.10</td>
</tr>
<tr>
<td>Cabling</td>
<td>BS 4737: Part 3.30</td>
</tr>
</tbody>
</table>

### 1.1.6.3 CCTV System

Where indicated in the drawings and specification, a CCTV system should be provided in accordance with BS EN 50132: Part 7.

The systems shall consist of surveillance equipment, controller and control matrix, telemetry transmitters and receivers, monitors (CRT, plasma or LCD as required) and data collection equipment (DVR, VR, server).

Cameras shall be of the static or pan – tilt – zoom type, covert or standard dependent upon the requirements of the project. Housings shall be suitable for the location that they are to be installed.

Picture quality, colour, size and frame rate shall be determined in the particular specification.

Cabling medium shall be either RG/59 or UTP cables as recommended by the supplier.

Power supplies shall be provided as required by the manufacturer of the CCTV systems, these power supplies shall serve an individual item of equipment or a group of equipment as required. The use of power supplies with variable outputs may be utilised where voltage drop may be problematic.

The power supplies shall be either supported by UPS, standby power circuits connected to a generator or by integral battery backup. The final requirements resulting from a loss of normal service electrical supply shall be in accordance with the particular specification.

### 1.1.6.4 Access Control System

Access control system including audio intercom and video intercom systems shall conform to the requirements of BS EN 50133: Part 1 and in accordance with BS EN 50133: Part 7.

The system shall consist of locks, audio visual interfaces, user identification devices (proximity cards, swipe cards, and so on), readers, keypads, power supply units and control system devices (field and headed).

Equipment shall be selected with appropriate IP protection for its location.

The system shall monitor all field controllers all of the time, and the systems shall be capable of generating a log of usage and also warnings and alarms as required.

Power supplies shall be provided as required by the manufacturer of the access control system, these power supplies shall serve an individual item of equipment or a group of equipment as required. The use of power supplies with variable outputs may be utilised where voltage drop may be problematic.
The power supplies shall be either supported by UPS, standby power circuits connected to a generator or by integral battery backup. The final requirements resulting from a loss of normal service electrical supply shall be in accordance with the particular specification.

1.1.7 **Audiovisual / Telecommunications**

**1.1.7.1 Telecommunications**

Telephone cabling and equipment supply and installation shall be carried out by an approved Bahrain Telecommunications Company contractor specialising in telecommunications installations.

All telephone related installations shall be carried out in accordance with the Bahrain Telecommunications Company standard specifications and regulations together with this specification and the project drawings and particular specification.

Telecommunications equipment and telecommunications cabling shall comply with the requirements of BS 7671.

Supply and install land cableways, empty conduits with draw wires, trunking, telephone points and outlets, PVC ducts, telephone junction boxes and manholes shall all be as required on the project drawings.

Telephone outlets shall be of the same pattern as the standard electrical accessories and installed at a similar height.

**1.1.7.2 Structured Cabling Systems**

The structured cabling system shall comply with the following standards as applicable to the project:

- BS EN 60950
- BS EN 50173 and 50174
- ISO/IEC 11801
- ANSI/EIA/TIA relevant standards

A structured cabling system shall be provided, where indicated in the drawings and specifications, for telephone and computer networks, including distribution frames, patch panels, cabinets, patch cords, outlets, adapters, conduits, PVC ducts and junction boxes in accordance with the project design documentation.

Backbone cabling shall be optical fibre cabling, either single mode or multimode.

Exact details of the structured cabling systems shall be referred to the particular specification.

The client wide area network connections shall be arranged with the service provider in accordance with the clients requirements.

All data communication system equipment shall be compatible, and does not adversely affect any other equipment installed in the same location.

**1.1.7.3 Public Address System**

A public address system shall be provided in accordance with the requirements of BS 6259 where indicated on the project drawings.

Connection to Fire Alarm System shall be in accordance with BS EN 60849 and BS 5839.

Emergency Sound Broadcast shall be to BS EN 60849.
A public address and sound amplification specialist shall be engaged to develop design, supply, install, commission and set to work a public address and sound distribution system in accordance with BS 6259. All equipment and systems shall be designed and installed to provide electromagnetic compatibility within the system and with any other systems installed in the same locations.

1.1.8 Radio / TV / SMATV

A centralised aerial/antennae system shall be provided, with distribution throughout the building where indicated in the detailed specification/drawings.

All cabling, antennae’s and aerials, splitters, distribution amplifiers and headed equipment shall be provided, as required to provide a complete system.

A specialist shall be engaged to develop the design and install, test, commission and provide maintenance for the duration of the defects liability period. The installation shall be in accordance with BS EN 60728.

Where the system is a centrally distributed system inclusive of decoders and channel provision the specialist shall agree with the client the channel list.

1.2 Delivery Control, Handling, Storage and Protection

1.2.1 Delivery

Delivery of all materials brought to site shall be recorded by means of delivery sheets.

All materials shall only be delivered to site after getting the approval of the engineer and the approval of the materials shall be granted through Material Approval Certificate (MAC).

These records shall be maintained on site and may be available for review by the engineer if requested. Items of equipment will not be considered completely on site unless all accompanying installation documentation and ancillaries are included within the delivery.

Large plant items and items of large monetary value shall be delivered by the manufacturer supplier in proprietary crates/packaging using vehicles intended for the purchase.

The Engineer shall be notified in advance of such large plant items arriving at site to review the status of equipment and packaging at time of receipt.

All relevant accompanying documentation shall be included with the equipment at the time of delivery and appropriate checks will be made ensuring the documentation and delivered items are in accordance with each other.

Where the Contractor obtains material early, for example for financial benefits of early purchasing, but chooses to store the items off site in his own premises, the above statements shall remain applicable.

1.2.2 Handling

All materials entering the site shall be handled at all times in a safe manner between delivery to site stores or from stores to location of final installation.

Handling of all material shall in all instances be in accordance with the manufacturers recommendations. All material delivered to site shall be accompanied by the relevant manufacturer’s data referring to the handling of the item.
Particular importance shall be given to the handling of large plant items and large monetary value items. Any damage caused during to handling of material and plant on site shall be reported to the Engineer at the earliest possible time.

The Contractor shall ensure that all plant required to move material and equipment is available on site at the time needed.

1.2.3 Storage and Protection

Agreement for location and size of site stores shall be agreed in advance of mobilising the site.

Storage of material shall be in accordance with the requirements of the manufacturer.

Particular importance shall be given to items requiring stable climatic conditions (temperature, humidity and sunlight) to ensure that they are not damaged between time of supply from the manufacturer and the time at which they are to be installed.

Where required and approved by the Engineer, certain parts of equipment may have to be installed at a later date than the bulk of the equipment; for example, UPS batteries may be installed later than the cabinet ensuring that air conditioning is working prior to their installation.

Storage of material will be in 3 categories which shall include:

- Internal storage
- Internal storage in climatic controlled environment
- External storage

Whilst in storage the Contractor shall ensure the protection of materials, including security of such material and also the physical protection.

Any such items of equipment delivered to site in crates or containers shall remain in its packaging until the time of installation, the crates or containers shall be opened to check the equipment upon arrival at the site, but then re-sealed to prevent damage from occurring whilst in storage.

Full 24-hour security shall be provided to guard stores of equipment containing high-value items to the point at which the Contractor plans to install the equipment.

2. PART 2 METHODOLOGY AND WORKMANSHIP

2.1 Installation

The installation of all material and equipment shall be in accordance with the requirements of the manufactures in all instances, and Module 01 of this document with regard to standard items applicable to all packages.

Where a discrepancy arises between the information provided in the Module 01 and this works section, the information contained herein will take precedence.

The contractor shall ensure that all equipment is supplied complete with all requisite components to provide a completed system and shall also ensure that any plant, material, fixings, fuel, and so on, required to complete the installation is obtained to facilitate the relevant installation.

Prior to installing plant and equipment the Contractor shall satisfy himself that the location
is suitable for the installation, free from water and dust and sealed from the external climatic conditions as required.

Any conditions that may jeopardise the installation shall be brought to the attention of the Engineer at the earliest possible time.

The installation shall meet the design intention and be in accordance with the approved shop drawings. Particular attention shall be paid to large plant items where space provision may be allocated for future use or extensions and where services have been coordinated on the design drawings/shop drawings, since any deviation from the design may impact other services.

2.2 Site Inspections, Testing and Commissioning

With respect to the high voltage aspect of the installation, HB 10210 shall be applied.

For low voltage systems, following connection of the equipment and plant, inspection shall precede testing and shall be carried out prior to energising of the electrical supply. The electrical inspections shall be in accordance with the requirements of BS 7671, Section 712 and EDD rules and regulations.

Following satisfactory factory testing, in the presence of the Engineer, and dispatch to site, at the time of installation the Contractor shall test the complete electrical installation to ensure the completeness of the installation. Where necessary these tests will be performed either with the power on or off.

The testing shall be undertaken in accordance with the requirements of BS 7671, section 713, and those of the local electricity authority, and shall include but not be limited to:

- Continuity of protective conductors including main and supplementary equipotential bonding
- Continuity of ring final circuit conductors
- Insulation resistance
- Site applied insulation
- Protection by separation of circuits
- Protection against direct contact by barrier or enclosure provided during erection
- Insulation of non conducting floors and walls
- Polarity
- Earth electrode resistance
- Earth fault loop impedance
- Functional testing
- Visual non-destructive testing

In addition to the standard electrical tests listed above, additional tests shall be performed by the Contractor to ensure the correct operational requirements are met by all equipment and plant, hardware and software as appropriate.

Where necessary, these tests are to be performed by specialist contractors or by the manufacturer/supplier representatives.

Where necessary specialist test equipment shall be utilised by the Contractor or his sub-contractors, and this requirement shall be deemed to be included in the contract price.

Artificial lighting tests of illumination levels shall be scheduled, indicating average and minimum lux levels achieved in the working place once wall and floor finishes have been applied (for reflectances).
Emergency lighting levels shall also be tested and scheduled in a similar manner to BS 5266 and NFPA 101 and the requirements of the Civil Defence.

A testing and commissioning report shall be provided to the Engineer at the completion of the tests for comment and a final set of testing and commissioning results incorporated into the O&M manuals.

2.3 Staff Training

Following satisfactory testing and commissioning of the installation and prior to the occupation of the building, maintenance staff will be trained by the Contractor in the use of the equipment and appropriate knowledge of the system.

This training may be performed on site or at Manufacturer’s premises and shall include practical and theory based training as appropriate.

Adequate notice shall be given to the Client to ensure the most suitable persons are available for the training.

2.4 Completion and Handover

2.4.1 General

Irrespective of the time of initial testing and commissioning the Contractor shall ensure that within the defects liability period he returns to the site and undertakes re-testing of the identified equipment during peak (summer) load conditions.

Throughout the defects liability period the Contractor may receive notification by the Client that various faults have arisen in the system. These shall be attended to within the minimum amount of time.

The Contractor shall carry out a thorough detailed examination of the installations during the eleventh and twelfth month of the defects liability period and shall put right any outstanding works or defects that might have occurred under the Defects Liability Period in the Conditions of Contract.

On completion of such works, and agreement that the requirements of the Conditions of Contract and Specification have been met, the Engineer will authorize a Certificate of Making Good Defects.

To facilitate the final handover the client must be in complete possession of all record information and satisfactory O&M manuals.

When the Contractor has demonstrated to the Engineer and to their complete satisfaction that the works are operating as intended within the design limits and tolerances of the manufactured items, then the Engineer will issue a certificate of taking over, subject to the clearance of any outstanding items or defects within 14 days of the date of the Certificate. At this time the responsibility for the operation of all the certified works will pass from the Contractor to the Client or as otherwise agreed with the Engineer.

Record Drawings shall be provided for the systems identified.
3. **PART 3 SUMMARY**

3.1 **Summary of Requirements**

3.1.1 **Source Approvals**

3.1.1.1 **Definitions**

**Supplier Pre-Qualification Documentation:**

Adequate information of the supplier’s organization to allow pre-qualification shall be provided.

**Specialist Contractor Pre-Qualification:**

Adequate information of the Specialist Contractor organization to allow pre-qualification shall be provided.

**Compliance Statement:**

Statement or checklist confirming compliance with the Contract shall be provided.

**Certified Type Tested Data:**

Manufacturer’s certified type tested data for specific items of equipment or components shall be provided.

**Country of Origin:**

Country where item of equipment or component is manufactured shall be stated.

**Dimensioned Manufacturer’s Drawings:**

Drawings of the item of equipment indicating all critical or major dimensions shall be provided.

**Associated Shop Drawings:**

Shop drawings showing connecting or interfacing services or equipment demonstrating correct location, positioning and adequate provision for maintenance access, operational needs and service connections, shall be provided.

**Manufacturer’s Certified Performance Data:**

Performance data certified by the Manufacturer’s R & D section and is not catalogue data shall be provided.

**Copy of Third Party Approvals:**

Any necessary applicable third-party approval documentation, such as independent testing organizations, for example, Fire and Life Safety testing, Underwriters, Laboratory, Loss Prevention Council, British Board of Agreement, shall be provided.

**Programme of Factory Tests and Proposed Dates:**

Where applicable, those items of equipment to be factory tested shall be programmed with agreed dates and shall suit the construction programme.

**List of Projects:**
A list of projects of similar nature on which the item has been successfully installed shall be provided.

Visits to Similar Installations:

An offer by the Contractor for a visit to similar installations, to allow inspection of the item in operation, shall be made.

Sample Warranty:

Adequate information of the detailed warranty that will be offered shall be provided in order to ensure all contractual obligations are met.

Lead Time and Delivery Program:

Full and detailed lead time for an item of equipment showing all time periods within the delivery period shall be provided. This shall include all necessary transportation times, customs clearance along with approval periods, manufacturing times testing and acceptance.

General Installation Data:

Adequate data of installation requirements shall be provided. This shall include handling and protection requirements and assembly of major components.

Samples:

Samples of specific items shall be provided as directed.

Special Finishes:

Data confirming special finishes on items of plant and equipment such as protective coatings for saline atmospheres, corrosive atmospheres or specific colours to suit interior design, and so on, shall be provided.

3.1.1.2 Source Approval Requirements

The information listed in Table 7 shall be submitted. The rows of Table 7 shall be expanded to include all items of the installation, and expanded list shall be to the approval of the Engineer.
<table>
<thead>
<tr>
<th>Supplier Pre-Qualification Documentation</th>
<th>Specialist Contractor Documentation</th>
<th>Compliance Statement</th>
<th>Certified Type Tested Data</th>
<th>Country of Origin</th>
<th>Dimensioned Manufacturers Dregs</th>
<th>Associated Shop Drawings</th>
<th>Manufacturers Certified Performance Data</th>
<th>Copy of Third Party Approvals</th>
<th>Program of Factory Tests</th>
<th>Detailed List of Projects on Which Item has been used</th>
<th>Visit to Similar Installation</th>
<th>Sample Warranty</th>
<th>Lead Time and Deliver Program</th>
<th>General Installation Data</th>
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<th>Special Finishes</th>
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Table 7: Summary Requirements for Type Approval

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<th>Compliance Statement</th>
<th>Certified Type Tested Data</th>
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<th>Dimensioned Manufacturers Dregs</th>
<th>Associated Shop Drawings</th>
<th>Manufacturers Certified Performance Data</th>
<th>Copy of Third Party Approvals</th>
<th>Program of Factory Tests</th>
<th>Detailed List of Projects on Which Item has been used</th>
<th>Visit to Similar Installation</th>
<th>Sample Warranty</th>
<th>Lead Time and Deliver Program</th>
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3.1.2 Delivery Control, Storage, Handling and Protection

3.1.2.1 Definitions

Method Statement:
All necessary data shall be provided to demonstrate the correct delivery control, storage, handling and protection.

Delivery Documentation:
Any necessary documentation, including custom clearances, inspection reports, prior to shipping, after shipping and transport company paperwork, and so on, shall be provided.

Hazard/ Risk Data Sheet:
Adequate hazard and risk data identifying any physical, chemical, biological or other such hazards associated with the item being delivered shall be provided. This shall include all necessary procedures for eliminating hazard or reducing risk.

Request for Inspection:
Inspection shall be made when item first delivered to site or at agreed storage facility.

Delivery Inspection Condition Report:
Full documentation shall be provided in the form of a report on the conduction of the delivered item. This shall include photography.

Ancillaries Included:
Any ancillaries, spare parts, components, tools, ad so on, delivered with the item required for assembly or installation shall be itemised, for example, temperature sensors and energy meter.

Storage:
Internal, external air conditioned or secure storage or a combination for the delivered item shall be provided.

Factory Inspection and Testing Report, Setting to Work Procedure O&M Instructions, and Warranty:
All necessary documentation shall be provided at the time of delivery. Original copies shall be provided and shall be issued to the Engineer. These documents shall form the basis of the overall record documentation.

3.1.2.2 Source Approval Requirements

The information listed in Tables 8 and 9 below shall be submitted. The rows of Tables 8 and 9 shall be expanded to include all items of the installation, and expanded list shall be to the approval of the Engineer.
### Table 8: Summary Requirements for Delivery Control, Handling Storage and Protection

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<thead>
<tr>
<th>Utility Distribution</th>
<th>Delivery Control, Handling, Storage and Protection</th>
<th>Delivery Documentation</th>
<th>Hazard / Risk Data Sheet</th>
<th>Request For Inspection</th>
<th>Delivery Inspection Condition Report</th>
<th>Ancillaries Included</th>
<th>Internal Storage</th>
<th>External Storage</th>
<th>Air Conditioned Storage</th>
<th>Secure Storage</th>
<th>Factory Inspection and Testing Reports</th>
<th>Setting to Work Procedure</th>
<th>O&amp;M Instructions</th>
<th>Warranty</th>
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Table 8: Summary Requirements for Delivery Control, Handling Storage and Protection

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Table 9: Requirements for Methodology and Workmanship for Installation (Contin’d)

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<td>Method Statement for Installation And Quality of Workmanship</td>
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<td>Site Installation Risk Assessment</td>
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<td>Setting to Work Procedure</td>
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<td>Regulation Procedure (Using Design Parameters)</td>
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<td>Record / Document Final Commission Measurements</td>
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Audio – Visual / Telecoms

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3.1.3 Completion and Handover

3.1.3.1 Definitions

All record documentation collected throughout the contract duration shall be provided. The records shall be indexed and collated. The records shall include as scheduled:

- Final commissioning measurement data
- Test reports
- Inspection reports
- All Method Statements and Installation procedures
- Final /last material and shop drawing submittals
- Final originals of standard one year and extended warranties
- Record drawings
- Operating and Maintenance instructions
- Planned preventive maintenance schedules
- Emergency contact details / telephone numbers
- Service contracts
- Staff training schedule
- Final handover statement

During and at the end of the defects liability period the following shall be provided:

Recommissioning schedule.

All equipment and systems shall be recommissioned during the defects liability period. A project finishes at any time in the calendar year and the commissioning may not be in optimal conditions as either peak or minimum part load conditions are only experienced or achieved full occupancy.

Final handover report.

This is any amendment to the initial handover report and shall include the results of any re-commissioning, completion and rectification of any defects, status of the condition and maintenance of the systems at the end of the defects liability period.

3.1.3.2 Source Approval Requirements

The information listed in Table 10 shall be submitted. The rows of Table 10 shall be expanded to include all items of the installation, and the expanded list shall be to the approval of the Engineer.
Table 10: Requirements for Completion and Handover

<table>
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<tr>
<th>Requirements for Completion and Handover</th>
<th>Final Commissioning Measurements and data</th>
<th>Test Reports</th>
<th>Inspection Reports</th>
<th>Method Statements and Installation Procedures</th>
<th>Final Material and shop drawing submittals</th>
<th>Final original of warranties (Standard 1 year)</th>
<th>Final original of warranties (extended)</th>
<th>Record drawings</th>
<th>Operating and Maintenance Instructions</th>
<th>Planned preventive maintenance schedules</th>
<th>Emergency Contact details (Phone numbers)</th>
<th>Service contracts</th>
<th>Staff training schedule</th>
<th>Initial Handover Statement</th>
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<th>Method Statements and Installation Procedures</th>
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<th>Final originals of warranties (Standard 1 year)</th>
<th>Final originals of warranties (extended)</th>
<th>Record drawings</th>
<th>Operating and Maintenance Instructions</th>
<th>Planned preventive maintenance schedules</th>
<th>Emergency Contact details (Phone numbers)</th>
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Table 10: Requirements for Completion and Handover (Contin’d)

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<th>Inspection Reports</th>
<th>Method Statements and Installation Procedures</th>
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<th>Final originals of warranties (extended)</th>
<th>Record drawings</th>
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<td>Specification for high-voltage busbars and busbar connections</td>
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<td>Specification. Two-pole and earthing-pin plugs, socket-outlets and socket-outlet adaptors</td>
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<td>Hot dip galvanized coatings on iron and steel articles</td>
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<td>Specification for automatic change-over contactors for emergency lighting systems</td>
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BS 6436 Specification for ground mounted distribution transformers for cable box or unit substation connection
BS 6633 Method for measurement and reporting of local vibration data of ship structures and equipment
BS 6724 Electric cables. Thermosetting insulated, armoured cables for voltages of 600 V/1,000 V and 1,900 V/3,300 V, having low emission of smoke and corrosive gases when affected by fire
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<td>Emergency lighting applications guide</td>
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<td>ISO/IEC IS 11801</td>
<td>Information technology. Generic cabling for customer premises</td>
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<td>NFPA 72</td>
<td>National fire alarm code</td>
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<td>NFPA101</td>
<td>Life safety code</td>
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<tr>
<td>TIA/EIA-568B</td>
<td>Commercial Building, Telecommunications Cabling Standard</td>
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### Abbreviations

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<td>ACB</td>
<td>Air Circuit Breakers</td>
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<tr>
<td>ACOP</td>
<td>Approved Code of Practice</td>
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<tr>
<td>ACRIB</td>
<td>Air Conditioning and Refrigeration Industry Board</td>
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<tr>
<td>ADCM</td>
<td>Acoustic Doppler Current Meters</td>
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<tr>
<td>AFMA</td>
<td>Australian Fisheries Management Authority</td>
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<td>AGMA</td>
<td>American Gear Manufacturers’ Association</td>
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<tr>
<td>AISI</td>
<td>American Iron and Steel Institute</td>
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<td>AS</td>
<td>Acceptance Strength</td>
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<tr>
<td>ASTA</td>
<td>Association of Short-circuit Testing Authorities</td>
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<td>ASTM</td>
<td>American Society for Testing Materials</td>
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<tr>
<td>ATS</td>
<td>Automatic Transfer Switch</td>
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<tr>
<td>BASEC</td>
<td>British Approval Service for Electric Cables</td>
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<tr>
<td>BOCA</td>
<td>Building Officials and Code Administrators</td>
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<td>BRE</td>
<td>Building Research Establishment Ltd.</td>
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<tr>
<td>BS</td>
<td>British Standards</td>
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<td>BSRIA</td>
<td>Building Service Research and Information Association</td>
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<tr>
<td>CBR</td>
<td>California Bearing Ratio</td>
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<tr>
<td>CCTV</td>
<td>Close Circuit Television</td>
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<tr>
<td>CECOMAF</td>
<td>Comité Européen des Constructeurs de Matériel Frigorifique</td>
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<td>CENELEC</td>
<td>Comité Européen de Normalisation Electrotechnique</td>
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<tr>
<td>CFC</td>
<td>Chlorofluorocarbons</td>
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<tr>
<td>CIBSE</td>
<td>Chartered Institution of Building Services Engineers</td>
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<tr>
<td>CHW</td>
<td>Chilled Water</td>
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<tr>
<td>CI</td>
<td>Cast Iron</td>
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<tr>
<td>CLW</td>
<td>Cooling Water</td>
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<tr>
<td>CM</td>
<td>Current Margin / Communication cable</td>
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<tr>
<td>CMP</td>
<td>Communication cable (Plenum)</td>
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<td>CP</td>
<td>Code of Practice</td>
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<tr>
<td>CPC</td>
<td>Circuit Protection Conductor</td>
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<td>CPT</td>
<td>Cone Penetration Testing</td>
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<tr>
<td>CRS</td>
<td>Categorised Required Strength</td>
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<tr>
<td>CRT</td>
<td>Cathode Ray Tube</td>
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<td>CRZ</td>
<td>Capillary Rise Zone</td>
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<td>CT</td>
<td>Current Transformer</td>
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<tr>
<td>c(UL)</td>
<td>Underwriters Laboratories Incorporated (Canada)</td>
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<tr>
<td>DEO</td>
<td>Defence Estate Organisation</td>
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<tr>
<td>DFT</td>
<td>Dry Film Thickness</td>
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<tr>
<td>DI</td>
<td>Ductile Iron</td>
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<tr>
<td>DIN</td>
<td>Deutsches Institut für Normung</td>
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<tr>
<td>DPC</td>
<td>Damp Proof Course</td>
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<td>DPDT</td>
<td>Differential Pressure, Differential Temperature</td>
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<td>DS</td>
<td>Durability Strength</td>
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<td>DVR</td>
<td>Digital Video Recorder</td>
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<td>DW</td>
<td>Ductwork Specification</td>
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<td>EA</td>
<td>Exhaust Air</td>
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<td>ECMA</td>
<td>European Computer Manufacturers Association</td>
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<td>ECR</td>
<td>Extra Chemical Resistant</td>
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<td>EIA</td>
<td>Environmental Impact Assessment/ Electronic Industries Alliance</td>
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<tr>
<td>EMG</td>
<td>Electromagnetic Compatibility</td>
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<tr>
<td>EPDM</td>
<td>Ethylene-propylene-diene-monomer copolymer</td>
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<td>FA</td>
<td>Fresh Air</td>
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<td>FBA</td>
<td>Factory Built Assembly</td>
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<tr>
<td>FRP</td>
<td>Fibre Reinforced Polymer</td>
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<tr>
<td>FSC</td>
<td>Forest Stewardship Council</td>
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<td>GANA</td>
<td>Glass Association of North America</td>
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<td>GGBS</td>
<td>Ground Granulated Blast-furnace Slag</td>
</tr>
<tr>
<td>GMS</td>
<td>Galvanized Mild Steel</td>
</tr>
<tr>
<td>GRC</td>
<td>Glass Reinforced Cement/Glass Reinforced Concrete</td>
</tr>
<tr>
<td>GRP</td>
<td>Glass Reinforced Plastics</td>
</tr>
<tr>
<td>HCFC</td>
<td>Hydrofluorocarbons</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
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<td>HEPA</td>
<td>High Efficiency Particulate Air</td>
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<td>HRC</td>
<td>High Rupturing Capacity</td>
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<td>HSFG</td>
<td>High Strength Friction Grip</td>
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<tr>
<td>HV</td>
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<tr>
<td>HVCA</td>
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<tr>
<td>ICBO</td>
<td>International Conference of Building Officials</td>
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<tr>
<td>IGCC</td>
<td>Insulating Glass Certification Council</td>
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<tr>
<td>IGE/UP</td>
<td>Institution of Gas Engineers – Utilization Procedures</td>
</tr>
<tr>
<td>IP</td>
<td>Ingress Protection</td>
</tr>
<tr>
<td>ISAT</td>
<td>Initial Surface Absorption Test</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standard Organization</td>
</tr>
<tr>
<td>ITP</td>
<td>Inspection Testing Plan</td>
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<tr>
<td>KD</td>
<td>Klin Dried</td>
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<tr>
<td>kVA</td>
<td>Kilovolt Ampere</td>
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<td>LCD</td>
<td>Liquid Crystal Display</td>
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<td>LED</td>
<td>Light Emitting Diode</td>
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<td>LPG</td>
<td>Liquid Petroleum Gas</td>
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<tr>
<td>LSOH</td>
<td>Low Smoke Zero Halogen</td>
</tr>
<tr>
<td>LSF</td>
<td>Low Smoke and Fume</td>
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<tr>
<td>LV</td>
<td>Low Voltage</td>
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<tr>
<td>MCB</td>
<td>Miniature Circuit Breaker</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>MCCB</td>
<td>Moulded Case Circuit Breakers</td>
</tr>
<tr>
<td>MDD</td>
<td>Medium Density Fireboard</td>
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<tr>
<td>MDD</td>
<td>Maximum Dry Density</td>
</tr>
<tr>
<td>MDPE</td>
<td>Medium Density Polyethylene</td>
</tr>
<tr>
<td>MEP</td>
<td>Mechanical Electrical Plumbing</td>
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<tr>
<td>MICC</td>
<td>Mineral Insulated Copper Covered Cable</td>
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<tr>
<td>MIO</td>
<td>Micaceous Iron Oxide</td>
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<tr>
<td>MMI</td>
<td>Man Machine Interface</td>
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<td>MOD</td>
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<td>MS</td>
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<td>MSDS</td>
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<tr>
<td>MSRPC</td>
<td>Moderate Sulphate Resistance Portland Cement</td>
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<tr>
<td>N</td>
<td>Nitrogen</td>
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<tr>
<td>NDFT</td>
<td>Nominal Dry Film Thickness</td>
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<tr>
<td>NEMA</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NRC</td>
<td>Noise Reduction Coefficient</td>
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<td>NS</td>
<td>Norwegian Standard</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>O/D</td>
<td>Outside Diameter</td>
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<tr>
<td>ODP</td>
<td>Ozone Depletion Potential</td>
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<tr>
<td>OFS</td>
<td>Oil Fired (Appliance/Equipment) Standard</td>
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<tr>
<td>OFTEC</td>
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<td>O&amp;M</td>
<td>Operation and Maintenance</td>
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<tr>
<td>OPC</td>
<td>Ordinary Portland Cement</td>
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<tr>
<td>PD</td>
<td>Published Documents</td>
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<tr>
<td>PE</td>
<td>Polyethylene</td>
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<td>PFA</td>
<td>Pulverised Fuel Ash</td>
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<td>PFC</td>
<td>Power Factor Correction</td>
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<tr>
<td>PM</td>
<td>Project Manager</td>
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<td>PTFE</td>
<td>Polytetrafluoroethylene</td>
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<tr>
<td>PVC</td>
<td>Polyvinylchloride</td>
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<tr>
<td>PVC-u</td>
<td>Unplasticised Polyvinylchloride</td>
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<td>PWNTAG</td>
<td>Pool Water Treatment Advisory Group</td>
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<tr>
<td>QA/QC</td>
<td>Quality Assurance/Quality Control</td>
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<td>RA</td>
<td>Return/Recycled Air</td>
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<td>Residual Current Circuit Breaker</td>
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<td>R&amp;D</td>
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<td>REFCON</td>
<td>Register of Companies Competent to handle refrigerants</td>
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<td>RPM</td>
<td>Reinforced Plastic Mortar</td>
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<td>RPZ</td>
<td>Reduced Pressure Zone</td>
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<td>RTD</td>
<td>Resistant Temperature Detector</td>
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<td>RTR</td>
<td>Reinforced Thermosetting Resin</td>
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<td>SA</td>
<td>Supply Air</td>
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<tr>
<td>SBCCI</td>
<td>Southern Building Code Congress International (Incorporated)</td>
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<td>SDR</td>
<td>Standard Dimension Ratio</td>
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<td>SIS</td>
<td>Swedish Institute of Standards</td>
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<td>SP</td>
<td>Super-plasticizing</td>
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<td>SPDT</td>
<td>Single Pole Double Throw</td>
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<td>Sulphate Resistance Portland Cement</td>
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<td>SSPC</td>
<td>Steel Structures Painting Council</td>
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<td>UPS</td>
<td>Uninterruptible Power Supply</td>
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<td>Unshielded Twisted Pair</td>
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<td>UV</td>
<td>Ultra Violet</td>
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<td>Video Recorder</td>
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<td>WBP</td>
<td>Weather and Boil Proof</td>
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<td>W/C</td>
<td>Water Cement Ratio</td>
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<td>WIS</td>
<td>Water Industry Specification</td>
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<td>WP</td>
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<td>WRAS</td>
<td>Water Regulations Advisory Scheme</td>
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<tr>
<td>XLPE</td>
<td>Cross Linked Polyethylene</td>
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