ELECTRICAL SERVICES MATERIALS AND WORKMANSHIP SPECIFICATION

NG Bailey

CONTENTS

VERSION CONTROL

The tables below provide the current revision approval and revision history for this document.

Current Revision Approval

	Name	Job Title	Date
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00	April 2018	Original Issue
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INTRODUCTION

The purpose of this specification is to set out the NG Bailey material and workmanship quality standards for building services electrical installations.

The specification should be read in conjunction with the following documents:

- NG Bailey 'MySupplychain' catalogue
- NG Bailey 'MyMaterials' catalogue
- NG Bailey internal policies and procedures and best practices guides
- Where reference is made in this standard specification to In-house and industry, design / technical guides ,These guides give in-depth information on the technical requirements of particular systems and should be referred to when necessary

Delete this paragraph and the below options as appropriate to suit the purpose of the specification/document at tender/bid submission or prior to entering in to contract, in conjunction with the Bid manager and commercial director.

Option 1: The NG Bailey materials and workmanship specification shall take precedence over the client's specification and / or Employers Requirements.

Option 2: The intent of this specification is to provide a standard workmanship and materials technical specification (to be supplemented by a project specific particular specification).

Option 3: The intent of this specification is to set out the NG Bailey materials and workmanship quality standards for building services, where NG Bailey have provided 'Contractors Proposals', in the absence of, or alternative to a client specification.

1 Sub-stations

1.1 Packaged Sub-Stations

1.1.1 General

In this specification 'Packaged Sub-Stations' shall mean a HV / LV transformer, close coupled to an LV panel, the transformer being mechanically separated from the LV panel. The HV switchgear may be integral with the packaged sub-station or remote, depending on local network arrangements.

The entire packaged sub-station shall be assembled and tested by the same manufacturer for delivery to site as a composite unit.

It shall be naturally air ventilated and be suitable for operation in ambient temperatures of 0°C to 40°C.

The transformer / HV switchgear section(s) shall have a minimum degree of protection of IP 31 to the cubicle enclosure (with IP21 to the underframe). The LV switchgear section shall be as detailed in Section 4 of this specification.

1.1.2 HV Switchgear

Where the HV supply is derived from a ring main unit supplied by the Company, the RMU shall be of the metal clad type, suitable for 3 wire, 11 kV, 50 Hz operation, using vacuum interrupters or SF6 as an arc control medium.

The equipment must be sealed for life, and for pressurised equipment must incorporate a pressure-monitoring device.

Where SF6 (Sulphur Hexafluoride) is used as an arc control medium, arrangements for end of life recycling, reuse or safe disposal shall be documented in the Operation & Maintenance manual.

Only HV switchgear approved for use by the Distribution Network Operators (DNO's) shall be used (i.e. complying with EATS standard 41-36).

All HV switchgear shall also comply with the relevant requirements of BS EN 62271 series of standards. Certificates of verification of type test for short-circuit strength of components of each assembly shall be provided – preferably ASTA certification.

Unless specified elsewhere, HV switchgear associated with packaged sub-stations shall have a minimum short-circuit withstand rating of 250 MVA for 3 seconds.

The protection unit incorporated into the circuit breaker shall be as specified on the design drawings.

Where the associated HV switchgear is an integral part of the packaged sub-station, the connections between the HV circuit breaker and transformer shall be formed by single core cables to BS 6622 which must be adequately supported and braced against inrush and short circuit currents. Cable terminations shall be provided with the appropriate stress relief.

Pre-commissioning testing of all the HV/LV equipment must be carried out to the manufacturer's recommendations, and/or appropriate codes of practice.

Where the HV switchgear is remote, the transformer enclosure shall be fitted with either a top or bottom entry (as required) dry type HV cable box. The manufacturer will supply and install the HV bushings and flexible HV screened cable connections onto the transformer terminals. The 'tails' from the bushings to the transformer connections shall be adequately supported. A minimum bending radius of 20 x D shall be observed (where D is the core diameter, unless the cable manufacturer has confirmed a smaller radius is acceptable).

At the HV circuit breaker the proprietary termination kit shall be approved by both the cable manufacturer and the switchgear manufacturer.

1.1.3 Transformers

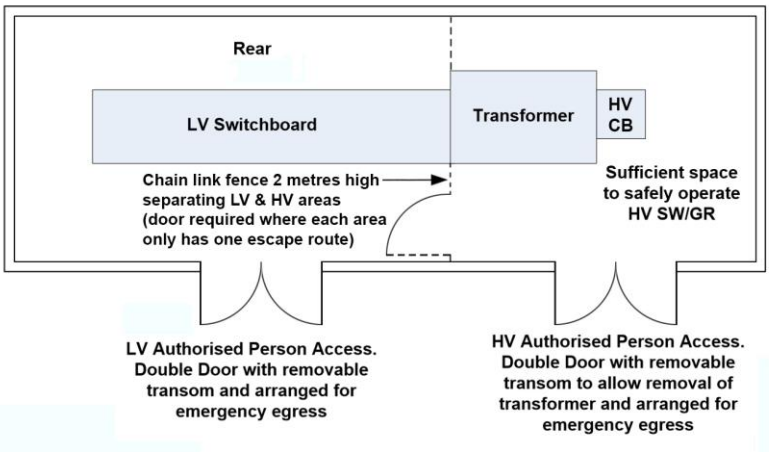
Indoor transformers for use with packaged substations, shall be of the cast resin insulated type. Refer to the section on 'Dry Type Transformers' for further details

1.1.4 Spatial Requirements

1.1.4.1 Segregation between HV & LV

In should be acknowledged that the 'switch room' becomes both a High Voltage and Low Voltage 'Closed Electrical Operating Environment'. Low Voltage Authorised Persons are likely to have different skills and training from those of a HV Authorised Person and permit systems for HV & LV will be different. It is therefore essential that the HV operating area is segregated from that of the LV. Without such segregation the whole of the switch room becomes the province of HV operational safety procedures and under the control of an HV Authorised Person. Sufficient segregation can be achieved by means of a chain link fence (at least 2 metres high) at the boundary of the HV and LV operating areas. Generally, as indicated in figure 1 below. Where only a single escape/egress route in each side of the switch room exists, a door should be fitted within the chain link fence secured by glass stopper type break glass. Access and egress widths and heights shall be maintained through to the final exit of the building, to comply with SI 2015 No 51 – The Construction (Design and Management) Regulations 2015; SI 1989/635 - The Electricity at Work Regulations, 1989; and HSr 25 - HSE, Memorandum of Guidance on the Electricity at Work Regulations 1989.

Figure 1 – Typical layout of a Packaged Substation 'Switch room'



1.1.4.2 **HV Switchgear and Operating Area**

Access to the HV operating area should only be allowed to HV Authorised, or Senior Authorised Persons (APs or SAPs). Preferably this should be by separate means of access and egress from that of the LV, generally as indicated in figure 1. Sufficient space should be allowed to enable those undertaking HV switching activities, to do so safely. Egress doors should be double doors, arranged for emergency egress (break-out) and additionally there should be a removable transom to allow the transformer to be both installed and removed. Non-authorised persons should only be allowed access to the HV operating area under a Permit-to-Work or a Limitation-of-Access Permit, issued by an HV Authorised Person.

Emergency-Power-Off (EPO) facilities shall be provided, immediately adjacent to the egress door and arranged to trip the HV supply.

1.2 Dry Transformers

1.2.1 General

Dry type transformers shall comply with the relevant parts of the following standards:

- BS EN 60076-11 (Power Transformers – Part 11: Dry type Transformers)
- BS EN 60076-1 (Power transformers – Part. 1: General)
- BS EN 60076-3 (Power transformers – Part. 3: Insulation levels, dielectric test and external clearances in air)
- BS EN 60076-5 (Power transformers – Part. 5: Ability to withstand short circuit)
- BS EN 60076-10 (Power transformers – Part. 10: Determination of sound levels)

This section of the specification covers privately (client) owned distribution transformers up to a maximum rating of 2.5MVA, operated on basic radial and open ring arrangements. Transformer capacities greater than 2.5MVA, or complex HV distribution networks will be covered under a project specific specification.

Dry type transformers shall be cast resin insulated, natural air-cooled type, having Class F and Class H insulation for the HV and LV windings respectively.

Dry type transformers shall be selected to suit the intended climatic environment in which they are installed. The transformer manufacturer shall declare and state on rating-plate the ‘Climatic Class’ of the transformer:

- **Class C1** – suitable for ambient temperatures above -5 degrees C (may be exposed to temperatures down to -25 degrees for transport and storage)
- **Class C2** – suitable for ambient temperatures above -25 degrees C

Dry type transformers shall be selected to suit the intended environment in which they are installed with respect to ambient temperature, humidity, condensation and pollution. The transformer manufacturer shall declare and state on the rating-plate the ‘Environmental Class’ of the transformer:

- **Class E0** – no condensation, negligible pollution (commonly achieved in a clean, dry indoor environment)
- **Class E1** – occasional condensation can occur when the transformer is de-energised, limited pollution
- **Class E2** – frequent condensation and/or heavy pollution

Dry type transformers shall be selected with due regard to their performance under fire conditions. The transformer manufacturer shall declare and state on the rating-plate the 'Fire Behavior Class' of the transformer:

- **Class F0** – No special fire hazard is envisaged
- **Class F1** – Transformer subject to Fire Hazard, restricted flammability, self-extinction, minimal emission of toxic substances and opaque smoke, halogen free.
- **Class F2** – By means of special provisions, the transformer will be capable of operating for a specified time. The requirements of class F1 shall also be met.

1.2.2 Performance Requirements

The transformer(s) shall be manufactured and tested in accordance with the relevant parts of BS EN 60076 (Power transformers) and BS EN 50588-1 and shall comply with European Union, Eco-design Directive, EU 548-2014.

The windings shall be arranged in Delta/Star (DYn11) with the neutral point brought out, unless specified otherwise.

Where it is anticipated that the load supplied by a transformer will introduce high levels of harmonic current in the transformer, the transformer shall be either:

- Suitably de-rated (oversized) to handle the effects of the harmonic current.
- K-rated to match the harmonic conditions expected to be produced by the load.

The transformer manufacturer/supplier shall be consulted as to the suitability of the transformer to supply the intended load.

The table below gives typical K-factors for different types of loads. It must be noted that a high percentage of the loads supplied by the transformer would need to be as the types listed in the table below to necessitate the need for a specific K-rated transformer.

Load Type	Typical K-Factor
Incandescent Lighting, Resistance Heating, Motors, Motor-Generators and Electromagnetic Control Devices	K-1
UPS with input filtering, HID Lighting, PLCs and Solid-State Controls (except variable speed drives), Induction Heaters and Welders	K-4
UPS without input filtering, Telecommunications (e.g. PBX), Multiple small power circuits in Health Care Facilities, School Facilities and Production Line Equipment.	K-13
Variable Speed Drives, Critical Care Facilities (e.g. Hospital operating rooms), Main Frame Computers and Circuits with exclusive Data Processing.	K-20
Small Main-Frames and Multiple Circuits in Commercial/Industria Environments, Medical and Educational Laboratories.	K-30
Other Loads identified as producing very high amounts of harmonics.	K-40

The voltage ratio shall be 11kV / 422V (at no-load) between phases at nominal tapping. The HV tappings of the transformer shall be ± 2½% and ± 5% at 11 kV with

off-circuit tap changers. The tap changing will normally be achieved by re-arranging bolted links.

Where the distribution voltage on the local electricity supply network is 6.6kV, dual ratio 6.6/11kV primary winding transformers shall be utilised. The use of a single ratio 6.6kV / 422 V transformer must have full agreement of the client/customer after seeking advice from the local DNO as to the future upgrade plans of the supply network.

1.2.3 Transformer Fittings

In addition to the requirements of other clauses in this section, the transformer(s) shall be provided with:

- Bi-directional, lockable rollers
- Two earthing points on the transformer core, plus one earthing point on the transformer enclosure.
- Lifting lugs for the transformer and enclosure assembly.
- Rating plate, to be permanently fixed in an accessible position to the outside of the transformer enclosure.

1.2.4 Winding Temperature Monitoring

The transformer(s) shall be provided with a winding temperature monitoring system to protect the windings against overheating. As a minimum the system shall consist of three temperature sensors (one per winding) and a tripping unit, with the output from the tripping unit being a volt-free changeover contact. The unit shall signal an alarm when the winding temperature reaches a pre-set level. If the winding temperature continues to rise to a point where damage to the winding could occur, then a second output shall operate to trip the HV supply circuit breaker.

1.2.5 Transformer Housing / Enclosure

The transformer shall be supplied with a suitable cubicle enclosure having a minimum degree of protection of IP 31 (with IP21 to the underframe).

1.2.5.1 Interlock System

Where the transformer enclosure is fitted with a hinged door, a mechanical key safety interlock system (Castell type) shall be arranged to allow access to the transformer compartment only when the HV circuit breaker supplying the transformer is locked in the circuit earth position and the main LV switchboard circuit breaker is locked in the off position.

Any variation to the above operational procedure must be agreed with the designer before any orders for equipment are placed.

Where provision of a Castell-type system is not operationally possible (for example, where the transformer is fed direct from the DNO who will not permit the Castell system on their equipment) then the transformer enclosure will be fitted with bolted-on panels. No hinged door arrangements will be permitted. The removable panels will be adequately labelled to indicate the presence of 11 kV within the enclosure.

1.2.5.2 **Forced Cooling (AF)**

In exceptional circumstances the enclosure design may incorporate fan-assisted cooling but only by prior approval of the designer. Where forced cooling is fitted a volt-free contact shall be provided (as an input to the building BMS or other remote monitoring system) to indicate when the fans are in operation.

1.2.5.3 **HV Connection Arrangement**

The transformer enclosure shall be supplied with either a factory coupled and fully tested:

- HV termination box (dry type) to BS 6435, with HV bushings and flexible HV screened cable connections onto the transformer terminals. The cable box shall allow the option for inverted installation. Cable boxes shall NOT be manufactured from cast iron.
- HV isolator/Circuit breaker with proprietary transformer connection kit and HV screened cable connections onto the transformer terminals
- Non-extensible HV Ring main Unit with proprietary transformer connection kit and HV screened cable connections onto the transformer terminals

The 'tails' from the bushings to the transformer connections shall be adequately supported. A minimum bending radius of 20 x D shall be observed (where D is the core diameter). Cable terminations shall be provided with the appropriate stress relief.

1.2.5.4 **LV Connection Arrangement**

Where the transformer is not directly coupled to the LV switchboard (as with a packaged substation arrangement) the enclosure shall be supplied with suitable provision for connection to the Main LV switchboard either by:

- A factory fitted LV cable box designed, manufactured and tested to BS 2562. All connections** from the cable box to the transformer LV terminals shall be fabricated, installed and tested by the transformer manufacturer prior to delivery to site. Gland plates shall be manufactured from Aluminium plate and drilled with pilot holes for each cable to be connected.
- A factory fitted busbar duct connection flange. All connections** from busbar flange to the transformer LV terminals shall be fabricated, installed and tested by the transformer manufacturer prior to delivery to site with Flexible links
  ** it is recommended that flexible connections are provided

1.3 Liquid Filled Transformers

1.3.1 General

Liquid filled transformers shall comply with the relevant parts of the following standards:

- BS EN 60076 (Power Transformers)
- BS EN 50464 (Three-phase oil-immersed distribution transformers)
- BS EN 50386 (Bushings for liquid filled transformers)

Ground / Pad mounted liquid filled transformers shall generally be for use in outdoor applications.

Mineral oil transformers shall not be used in indoor situations. An exception to this is when the transformer is located in a dedicated transformer enclosure sited at the external envelope of a building structure, where the enclosure is explosion blast and F120 fire protected from adjacent areas of the building.

Liquid filled transformers may be used in indoor situations when the insulating medium is synthetic oil (Midel or Silicon) however, in all installation circumstances, care shall be taken that the transformer location is bunded to prevent the escape of insulating medium into the general area or to external ground and / or water tables.

Liquid filled transformers shall generally be of the naturally cooled type (ONAN for mineral oil / KNAN for synthetic oil). Forced cooling (ONAF) will not be acceptable unless approved by the designer.

Transformer ratings shall preferably be based on ISO 3:1973 (Preferred numbers -- Series of preferred numbers). For electro-technical purposes, for transformers, this is: 315; 500; 800; 1000; 1250; 1600; 2000; 2500; 3000; 3500; 4000; 4500 kVA. For further information on the preferred number series, refer to clause 12 (informative) of this specification.

Where it is anticipated that the load supplied by a transformer will introduce high levels of harmonic current in the transformer, the transformer shall be either:

- Suitably de-rated (oversized) to handle the effects of the harmonic current.
- K-rated to match the harmonic conditions expected to be produced by the load.

The transformer manufacturer/supplier shall be consulted as to the suitability of the transformer to supply the intended load.

1.3.2 Performance Requirements

The transformer(s) shall be manufactured and tested in accordance with BS EN 60076 and BS EN 50588-1 and shall additionally generally comply with the requirements of ENATS 35-1, with cable boxes generally to BS2562. Where the LV cable arrangements differ from a standard arrangement applicable to a given transformer size, full cable details must be provided to the transformer manufacturer.

Transformer(s) shall comply with European Union, Eco-design Directive, EU 548-2014.

The windings shall be configured as Delta/Star (DYn11) with the low voltage neutral point brought out.

The voltage ratio shall be 11 kV / 422 V (no-load) between phases at normal tapping. The HV tappings of the transformer shall be ± 2½% and ± 5% at 11 kV. Tap changing shall be performed with the transformer de-energised by means of an externally operated ‘off-circuit’, self-positioning tapping switch. Provision shall be made for the locking of the tapping switch at any tapping position.

Where the distribution voltage on the local electricity supply network is 6.6kV, dual ratio 6.6/11kV primary winding transformers shall be utilised. The use of a single ratio 6.6kV / 422 V transformer must have full agreement of the client/customer after seeking advice from the local REC as to the future upgrade plans of the supply network.

Where the transformer is mineral oil filled, the liquid shall comply with BS EN 60296 and where synthetic, the liquid shall comply with BS EN 61099.

1.3.3 Transformer Fittings

The transformer tank shall be mounted on a skid base. Holes shall be provided at each end of the skid base for haulage purposes to allow for installation, removal and final positioning of the transformer.

The transformer shall be provided with rating and connection plates and labelling complying with BS EN 60076-1 and ENA TS 35-1.

The core and winding assembly shall be contained within a tank of welded, sheet-steel construction. Free breathing transformers shall be provided with a removable, flange-mounted coverplate or lid. Transformers shall be provided with bolt-on, panel-type radiators. Radiators for free-breathing transformers shall be provided with flanges for attachment to the tank by threaded studs or bolts. The tank shall be designed to avoid the creation of ledges or pockets where water could accumulate.

The tank shall be designed to permit movement of the finished transformer (i.e. complete with windings, radiators, ancillaries, coolant, cable boxes etc.), by craneage, winching, or jacking, without causing distortion, leading to subsequent coolant leakage.

Fittings shall comply with ENATS 35-1, with the following exceptions/additions:

1. The breather shall be provided with an integral insect screen and clearly visible desiccant filter. The desiccant shall be of an inert nature and shall not contain (blue) cobalt chloride; and
2. The combined drain and sampling connection/valve shall be fitted with a blanking plate or padlocking facilities and shall be clearly labelled.
3. If a conservator is provided it shall incorporate the following fittings:
    a. A pad-lockable drain valve, fitted with a threaded sealing plug; and
    b. A filling aperture, fitted with a threaded sealing plug.
4. The following fittings shall not be fitted to hermetically sealed transformers:
    a. A filling hole and cover; and
    b. A breather

1.3.4 Monitoring and Protection Equipment

The methods of coolant and / or winding over-temperature protection required / provided shall be as follows:

- Coolant / winding over-temperature protection systems shall incorporate separate alarm and trip functions.
- Local indication of coolant and/or winding temperature shall be provided. Indicators shall comprise °C scaled, dial indicating thermometers (minimum

diameter 150 mm), fitted with a re-settable maximum indicating pointer or digital thermometers.

- If the transformer incorporates a conservator tank, a gas and coolant surge operated (Buchholz) device shall be provided. The Buchholz device shall be fitted in an inclined section of the connecting pipe between the conservator and the transformer tank and incorporate the following features/facilities, as a minimum:
    - A float switch to initiate an alarm signal on accumulation of gas in the device;
    - An adjustable flow switch to initiate tripping of the transformer feeder on surge of coolant into the conservator;
    - A petcock to enable accumulated gas to be released/sampled, as appropriate;
    - A second petcock to enable float switch testing with compressed air; and
    - An inspection window.
- The alarm and trip contacts fitted to the float/flow switches shall be of the latching type and require manual resetting at the Buchholz device.

Hermetically sealed transformers shall be provided with a spring loaded, self-resetting pressure relief device (PRD), actuated by excess pressure in the transformer tank. The PRD set pressure shall be selected according to the type of transformer coolant used. The PRD shall be provided with a manually resettable switch, to initiate tripping of the transformer on PRD activation.

Alarm and tripping signals generated by coolant / winding over-temperature protection devices, Buchholz devices, PRDs, etc. shall be initiated by form C switches, rated at 10 A / 230 V DC. Switch contacts shall be volt free, normally open (NO) and energised to trip. The contacts shall be cabled to terminals in a common auxiliary cable box mounted on the transformer tank. The cabling shall be provided with earthed metallic protection, and the auxiliary terminal box shall be provided with an un-drilled gland plate; suitable for accommodating one outgoing cable gland for each alarm or trip circuit terminated. The IP rating of the terminal box shall be equivalent to that of the transformer.

1.3.5 Installation Requirements

Transformer installation shall be planned to provide a minimum of 1 metre clear area around the transformer, with double door or gate access of sufficient dimensions to allow the installation and / or removal of the transformer(s). Where more than one transformer is to be installed, each transformer shall be segregated from the other in a separate enclosure. Where the transformer(s) are of the mineral oil type, a minimum 2.1 metre high blast wall shall separate each transformer.

Where transformers are to be located in an indoor location, care shall be taken regarding breakout of noise and vibration to adjacent areas. E.g. do not site adjacent to occupied areas. Flexible connections are recommended when connecting to the LV bus bar.

Transformers must be stored in a clean and dry environment on a flat surface. If stored for more than two weeks a breather must be fitted.

Liquid filled transformers must be installed within a suitably bunded area capable of safely containing the full volume of coolant.

2 Standby Generators

2.1 General

Standby Generating sets and comply with the relevant parts of the following standards:

- BS ISO 8528-1 (Reciprocating internal combustion engine driven alternating current generating sets. Application, ratings and performance)
- BS ISO 8528-2 (Reciprocating internal combustion engine driven alternating current generating sets. Engines)
- BS ISO 8528-3 (Reciprocating internal combustion engine driven alternating current generating sets. Alternating current generators for generating sets)
- BS ISO 8528-4 (Reciprocating internal combustion engine driven alternating current generating sets. Controlgear and switchgear)
- BS ISO 8528-5 (Reciprocating internal combustion engine driven alternating current generating sets. Generating sets)
- BS ISO 8528-6 (Reciprocating internal combustion engine driven alternating current generating sets. Test methods)
- BS ISO 8528-7 (Reciprocating internal combustion engine driven alternating current generating sets. Technical declarations for specification and design)
- BS ISO 8528-8 (Reciprocating internal combustion engine driven alternating current generating sets. Requirements and tests for low-power generating sets
- BS ISO 8528-9 (Reciprocating internal combustion engine driven alternating current generating sets. Measurement and evaluation of mechanical vibrations)
- BS EN 50438 (Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks)

This section of the specification is only applicable for the applications listed below, and for individual reciprocating combustion engine driven generating sets rated up to 2500kVA. Where the Generator system(s) fall outside of this scope, a project or application specific generator specification shall be produced.

1. Emergency Generator Systems
2. Optional Standby Generator Systems

Emergency Generator Systems are installed as required to provide for public safety as mandated by law. They are intended to provide emergency power and lighting for short periods of time to:

- permit safe evacuation from buildings,
- support life safety and critical systems and services,
- maintain critical communication systems, facilities and infrastructure.

In the event of normal mains failure, emergency generator systems must be capable of automatically providing the power supply to all designated life safety supplies within 15 seconds. The emergency generator must be capable of sustaining the power supply for a minimum period of 3 hours.

Where a generator is used to supply emergency lighting it must be capable of automatically accepting the load within 5 seconds of normal power failure.

Where an emergency generator is required to support the load of critical communication systems (where there cannot be a break in the electrical supply), a UPS system will be necessary to support the load until the generator comes online. The

delay in changeover of the incoming supply to the UPS system will depend/dictate the rating and autonomy of the UPS/UPS batteries.

Optional Standby Generator Systems provide standby power where safety is not at stake, standby Generator systems are installed where:

- loss of power could cause economic loss or loss of business revenue,
- loss of power could cause inconvenience or discomfort,
- loss of power could result in damage to plant and equipment.

Each generating set shall be built, tested and supplied from a single manufacturer fully responsible for the manufacture/assembly of the engine, alternator, exhaust, fuel tanks & fuel delivery system, attenuators, design and manufacture of controls, container/housing (where applicable), building of set, factory test, factory warranty, shipping and on-site installation and commissioning.

Often a genset will be required to satisfy both 'Emergency' and 'Optional Standby' applications. Where this is the case the genset must meet all the requirements for Emergency operation.

Generating set power ratings shall be expressed in kVA at a frequency of 50hz and a power factor of 0,8 lagging. Generating sets shall have a nominal output voltage of 230/400V. The scope of this specification typically covers generating sets used in a Standby application. Generator ratings are designated as:

- **Standby Rating** (100% of the generators capacity, the generator used infrequently as backup to the main utilities supply)
- **Prime Rating** (typically 90% of standby rating, for unlimited use supplying a varying load)
- **Continuous Rating** (typically 70% of the standby rating, for unlimited use supplying a constant load)

Where the generator changeover controls/switchgear are incorporated (or partially incorporated/interfaced) into the main LV switchboard, the generator manufacturer shall liaise closely with the electrical designer and switchboard manufacturer to ensure all systems are fully compatible and capable of being integrated prior to any purchase orders being placed. The 'standard' methods of changeover control are:

1. Isolated (Single Generator)
    - Manual Changeover
    - Automatic Changeover
    - Automatic Changeover with No Break Return
2. Isolated (Synchronised Parallel Generators)
    - Manual Changeover
    - Automatic Changeover
    - Automatic Changeover with No Break Return
3. Embedded - single/parallel Generator(s) (outside the scope of this specification)

Where generators are designed for automatic changeover, automatic load shedding and load stepping switchgear, controls and monitoring shall be included.

Where Generators are designed to operate in synchronization with the Public Electricity Supply (PES) the generator and its associated control switchgear shall conform to the requirements of ENA Engineering Recommendation G99.

In order to economically size a generator, accurate information relating to the electrical loads being supported is required. Modern diesel genset engines utilise turbo chargers which to function optimally require the loads to be applied in a number of steps. As a rule of thumb it is good practice to allow the electrical loads to be applied in no fewer than 3 steps

- **Step 1** – Emergency/Life Safety Loads (typically 30-60% of full load)
- **Step 2** – Loads supplying systems with no or low inertia (e.g. lighting)
- **Step 3** – Loads supplying systems with higher inertia (e.g. heating/ventilation or loads supported by UPS systems until the generator is online)

Obviously, if a generator only supplies emergency/life safety loads, then each of the stepped loads must be automatically brought online within the required time (usually 15s) or an oversized generator is installed.

2.2 Genset

2.2.1 Engine

Unless otherwise specified the engine shall be a water cooled, 4 cycle, compression ignition, 1500 RPM, naturally aspirated or turbo-charged engine designed to run on diesel oil.

The engine shall be designed to run on diesel fuel to BS 2869:2017 class A1 or A2

The engine shall have an electronic governor and shall be capable of meeting performance class G3 as defined in BS ISO 8528-1.

2.2.2 Alternator

The alternator shall comply with the relevant parts of the following standards:

- BS 5000-3 (Specification for rotating electrical machines of particular types or for particular applications. Generators to be driven by reciprocating internal combustion engines. Requirements for resistance to vibration)
- BS 5000-11 (Specification for rotating electrical machines of particular types or for particular applications. Small-power electric motors and generators)
- BS 60034 [series] (Rotating electrical machines)

The alternator output voltage shall be 3 phase 400V.

The alternator shall have insulation and temperature rise Class ‘H’ (125C/40C)

The alternator shall be of the brushless type with directly coupled permanent magnet exciter (PMG).

Unless otherwise specified, the alternator shall have 2/3 pitch windings

The alternator shall be air cooled

The minimum degree of protection shall be IP22

2.2.3 Batteries

Unless otherwise specified, Generator starting batteries shall be 12V or 24V Lead Acid. Batteries shall have sufficient capacity for at least 3 attempts at starting the engine

2.2.4 Bulk Fuel and Fuel Storage

Relevant Legislation:

- The Control of Pollution (Oil Storage) (England) Regulations 2001
- The Water Environment (Oil Storage) (Scotland) Regulations 2006
- The Control of Pollution (Oil Storage) Regulations (Northern Ireland) 2010

All fuel pipework installed between the bulk fuel storage tanks and the generator or generator day tank shall be pipe in pipe.

Where additional bulk fuel capacity is provided, the generator manufacturer shall be consulted, and must approve the design and control philosophy of the bulk fuel delivery system.

Suitable arrangements/provisions must be provided for refueling (or topping up) generator day tanks and bulk fuel stores.

Where diesel fuel(s) intended to supply emergency and back-up generator systems are expected to be stored in excess of 12 months (at an ambient temperature of 20°C), or 6-12 months (at an ambient temperature of 30°C) they shall be routinely tested for the following contaminants:

- Water (free water, dissolved water & emulsified water)
- Microbial Growth (bacteria, yeast, mold & bio-films)
- Particle Contamination (rust, dirt, soot, wax, gums, organic compounds)

Contaminated fuels must be polished/cleaned or safely disposed of and replaced. Unless otherwise specified, the responsibility for undertaking any fuel quality testing and necessary cleaning/polishing or replacement shall rest with the building owner/operator.

The generator fuel requirements (Day tanks, Bulk Fuel Storage and associated controls and environmental considerations) will be further detailed in the project specific Electrical Specification.

2.2.5 Provision of Generator Load Bank Testing

The generator(s) shall be provided with suitable provision (connection/termination point and switching controls), and detailed method statement for the connecting and operation of either a permanent or temporary load bank.

2.3 Generator Environmental Requirements

2.3.1 Noise Control

The maximum permitted noise levels must be ascertained for the area around the generator. Maximum permitted noise levels;

- may refer to the total permitted noise levels, an understanding of the ambient noise level and the resultant noise level when the generator is operating at full load is required.
- may vary at different times of the day,
- may be dependent on whether the noise is continuous or intermittent
- may include noise limits at specific frequencies and consideration of tonal noise.
- may depend on the function or purpose of the generator (or other plant/equipment). Some applications may be exempt or have relaxed requirements.

Many Local Councils now include noise pollution assessments for new or refurbished developments as part of the planning application process. In such cases noise restrictions and permitted noise pollution levels should already have been considered prior to NG bailey being appointed. Where NG Bailey are appointed to undertake design at the early and conceptual stages of a project, engagement of an acoustic consultant shall be considered.

Determine the project specific maximum permitted noise levels and whether specific noise limits have been specified for individual items of Plant & Equipment.

If noise limitations are expressed as “total” a detailed assessment must be carried out to determine the maximum contributing noise criteria for each individual generator. (and main items of plant & equipment). Normally this would not fall within NG Bailey’s work scope and would be undertaken by a dedicated acoustic consultant.

It is the responsibility of the generator manufacturer to ensure that the generator being supplied conforms with the project specific noise requirements. A generator set is a complex noise source which generates noise from:

- the cooling fan(s)
- the engine
- the exhaust system

Because noise is directional careful consideration needs to be given to the location, orientation and distance of each generator noise source to the point(s) where the noise is considered objectional. It shall be the responsibility of NG Bailey to ensure the Generator manufacturer/supplier has all the necessary project specific information in order to design/supply a complaint overall generator system.

In the absence of any local authority, project or client specific noise limits the generator (or any of its component assemblies) shall not exceed 85db at 1 metre in free field conditions.

2.3.2 Air Pollution Control

Relevant Legislation:

- Local Authority Regulations
- The Clean Air Act 1993
- (EU) 2016/1628
- (EU)2017/654
- (EU) 2017/656
- (EU) 2017/655
- (EU) 2015/2193 - Medium Combustion Plant Directive (MCPD)

The MCPD has been brought into force across the UK through the following regulations:

- The Environmental Permitting (England and Wales) (Amendment) Regulations 2018
- The Pollution Prevention and Control (Industrial Emissions) (Amendment) Regulations (Northern Ireland) 2018.
- The Pollution Prevention and Control (Scotland) Amendment Regulations 2017.

The legislation and regulations listed above define the emission limits that apply to diesel engine driven generating sets with ratings from 1 – 50MWth (Thermal Rating)

Generators provided for the purpose of Back-up (Emergency or Stand-by) of the mains electrical supply are excluded from the requirements if:

- They are operated for the purpose of testing for no more than 50 hours per year (and are not used for any other function)
- If it can be demonstrated that a genuine need to test for more than 50 hours per year (requires special approval confirming no air quality exceedance)

Whilst back-up generators are excluded from the above legislation, local regulations and/or client/project specific requirements may apply.

Where generator emissions exceed the regulated, local or client/project requirements it will be necessary to reduce the emissions to the permitted levels using one or a combination of the following technologies. The generator manufacturer shall advise on the most suitable and economic solution.

- Exhaust Gas Recirculation (EGR)
- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Selective Catalytic Reduction (SCR)

3 HV Switchgear

3.1 General

For the purpose of this specification High Voltage (HV) is any voltage exceeding Low Voltage (ie: greater than 1000 V AC or 1500 V DC). The clauses in this specification are specifically referring to 6.6kV and 11kV.

High voltage switchgear and ancillary equipment shall comply with the following standards which are current at the time of publication:

Standard	Description
BS EN 60038:2011	CENELEC standard voltages
BS 159:1992	Specification for high voltage busbars and busbar connections
BS EN 62271-100:2009+A1:2012	High-voltage switchgear and controlgear. Alternating current circuit-breakers
BS EN 62271-1:2008+A1:2011	High-voltage switchgear and controlgear. Common specifications
BS EN 62271-200:2012	High-voltage switchgear and controlgear. AC metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV
ENATS 41-36	Energy Networks Association Technical Standard 41-36, Switchgear for service up to 36kV (Cable and overhead conductor connected)

High voltage switchgear shall be installed, operated and maintained in accordance with the manufacturer's instructions.

The manufacturer shall provide information on the following:

- A general description of the equipment with particular attention to the technical description of its characteristics and operation so that the user has an adequate understanding of the main principles involved;
- A description of the safety features of the equipment and the operation of the interlocks and padlocking facilities;
- As relevant, a description of the action to be taken to manipulate the equipment for operation, isolation, earthing, maintenance and testing.

The manufacturer should issue a maintenance manual including the following information:

1. Extent and frequency of maintenance
2. Detailed description of the maintenance work

3. Comprehensive drawings of the details of the switchgear and control gear important for maintenance, with clear identification (part number and description) of assemblies, sub-assemblies and significant parts
4. Limits of values and tolerances which, when exceeded, make corrective action necessary, e.g. low gas pressure etc.
5. Specification for auxiliary maintenance materials, including warning of known non-compatibility of materials
6. List of special tools
7. Tests after maintenance work
8. List of recommended spare parts

Once installed, high voltage switchgear and control gear shall only accessible to instructed (authorised) persons. It must be operated and maintained by skilled (authorised) persons.

Where 3 core cables are utilised, HV cable glanding to equipment(s) shall preferably be by means of the 'top hat' welded earth stud type, suitable for heat shrink terminations.

3.2 Cubicle Pattern Switchgear

Cubicle pattern switchgear shall be of the air insulated, encapsulated busbar, metal clad, vertical or horizontal isolation type arranged to form complete switchboards and suitable for installation in permanent sub-station buildings. Integral circuit earthing facilities shall be provided.

Only HV switchgear approved for use by the Distribution Network Operators (DNOs) shall be used (i.e. complying with ENATS Standard 41-36). It shall be constructed to provide a degree of protection no less than IP 31.

The switchgear shall be equipped with a set of 3 phase busbars manufactured from high conductivity copper and insulated in an approved manner. Approved mouldings shall be provided to cover all joints in the busbars and connections.

The busbars shall be suitable for extension with holes pre-drilled at both ends of the switchboard.

Circuit breakers shall be of the vacuum or SF_6 type and shall be of robust construction designed to ensure safety of all operational personnel.

Complete switchgear assemblies shall be provided with a minimum short circuit rating of 250 MVA at 11 kV for 3 seconds.

Circuit breakers shall be of the trip-free type fitted with either manual or motor wound spring closing mechanisms. Spring closing mechanisms shall be provided with means for charging the springs by hand.

Each operating mechanism shall be provided with a shunt trip device and means of local manual tripping by a lockable push button.

Every circuit breaker of cubicle pattern switchgear (whether fixed compact or withdrawable type) that incorporates electrical opening and closing mechanisms, shall

additionally be equipped with a 10 metre umbilical facility, such that opening and closing of circuit breakers can be carried out from a safe distance from the device.

Visible mechanical indication shall be provided to show whether the circuit breaker is open or closed and in service or earthed position. Spring closing mechanisms shall have a visual indicating device to indicate that the springs are charged or free.

Provision for earthing the cables of every unit, through the circuit breaker, shall be incorporated. Busbar earthing facilities shall be provided where specifically indicated.

Earthing of circuit cables shall be carried out on earthing plugs which shall form an integral part of the switchgear unit housing.

Earthing shall be achieved via an integral fault making earthing switch or via a portable earthing device, through the circuit breaker.

Each circuit breaker shall be fitted with all necessary auxiliary switches for indication, control, protection, metering, interlocking etc.

All auxiliary switches shall be mounted in accessible positions clear of the operating mechanism and shall be adequately shrouded.

All auxiliary switches shall be wired to the terminal rail on the fixed portion of the switchgear, segregated from the main circuits, and shall be arranged in the same sequence for all panels.

Interlocks shall be provided to prevent the following:

a) a closed circuit breaker from being withdrawn from or inserted into the primary isolating contacts;
b) the closing of a circuit breaker unless correctly located in the ‘service’ or ‘isolated / test’ position;
c) circuit breakers from being placed in fixed housings of different ratings. The interlocks shall prevent damage to isolating contacts, bushings and shutters.

An earth bar of not less than 25 mm x 3 mm hard drawn high conductivity copper shall be provided for the full length of the assembled switchboard.

To enable functional tests to be carried out, provision shall be made for temporarily completing the secondary circuits when the circuit breaker is in the isolated/test position. Any loose equipment necessary for this shall be included.

Facilities shall also be provided to enable primary and secondary injection tests to be performed.

Safety shutters of metal, effectively earthed, shall be provided to completely shroud the fixed isolating contacts for the circuit breaker busbar and feeder circuits when the circuit breaker is withdrawn. Busbar and feeder shutters must be capable of operation independently of each other and must be individually lockable in the closed position.

When one set of shutters is padlocked closed, it shall not be possible to touch any of the live metal behind the 'locked off' spouts whilst holding the unlocked shutter open.

All cable boxes and glands required for HV power and control multicore cables shall be supplied and fitted. Cable boxes shall be suitable for receiving cables terminated with dry type terminations.

Cable glands shall generally be of the 'top hat' welded earth stud type, suitable for heat shrink terminations.

Test evidence shall be provided to prove the through fault capability of the switchgear cable boxes with dry type terminated power cables.

Current transformers shall be provided as required for protection, metering etc. They shall be in accordance with BS EN 61869-2. All connections from CT secondary windings shall be brought out and wired to terminal blocks in the fixed portion of the switchgear. The secondary winding of each single phase CT and the star point of the secondary windings of each 3 phase group shall be connected to earth at one point only through a separately mounted bolted link.

Voltage transformers for protection and metering purposes shall comply with the requirements of BS EN 61869-3 and be fitted with removable HV fuses.

The L2 phase of the secondary shall be earthed via a bolted link.

The VTs shall have an earthed metal screen between primary and secondary windings.

VTs for synchronising purposes shall be TP&N star connected pattern.

All secondary wiring shall be identified by approved insulated and numbered ferrules and shown on the manufacturer's drawings. Bus wiring ferrules shall have numbers, which are prefixed at each of the switch panels to aid identification.

All fuses shall be of the HBC cartridge type to BS EN 60269 (fusing factor Class Q1), GEC 'T' series or approved equivalent. Fuse links and carriers/bases shall be of good quality insulating material. Removable neutral links shall be in white holders, with all fuses in black holders.

Fuses and links shall be logically and consistently grouped and shall be clearly labelled to show function, voltage and current ratings.

DC supplies for control and indication shall be provided for connection at one end of the switchgear panel. Bus wiring shall have disconnecting facilities between each panel in order that a panel can be isolated for maintenance purposes without breaking the bus wires. Terminal rails for control cables and secondary wiring shall be completely segregated from the main circuit. Sufficient terminals shall be provided to cater for all known connections plus 20% spare for future extensions. At least 100mm shall be allowed between rows of terminal rails to allow for making-off wiring. Terminals for DC circuits shall be of the 'spring loaded' variety.

3.3 Individual Units of HV Switchgear

Individual, fixed pattern high voltage switchgear units are used for protection of single transformer feeders, local isolation for items of equipment etc. Generally they fall into two groups: automatic circuit breakers or manually operated devices.

The switches/circuit breakers shall be suitable for 3 wire, 11 kV, 50 Hz operation, using vacuum interrupters or SF6 as an arc control medium.

The equipment must be 'sealed for life' and pressurised equipment must incorporate a pressure monitoring device. Only HV switchgear approved for use by Distribution Network Operators (DNO's) shall be used (i.e. complying with ENATS Standard 41-36).

Unless specified elsewhere, individual units of HV switchgear (and composite boards where multiple extensible units are used) shall have a minimum short-circuit withstand of 250MVA for 3 seconds.

Where individual units are used to protect transformers, they shall be fitted with a transformer earthing switch rated to make on to a fault created by a back feed through the transformer.

Unless the units are to be close-coupled on to transformers they shall be fitted with an Electricity Supply Industry (ESI) style, cable box.

Where there is provision, Voltage Presence Indicators (VPIs) shall be fitted.

Cable test access shall be provided to enable pressure test/fault location to be carried out.

Automatic circuit breakers shall be provided with a separate protection compartment suitable for TLF or IDMT relay. Refer to the project designer for details of the specific protection required.

3.4 Ring Main Units

Where the Company supplies a HV Ring Main Unit (RMU), the RMU shall be of the metal clad type, suitable for 3 wire, 11 kV, 50 Hz operation, using vacuum interrupters or SF6 as an arc control medium.

The equipment must be 'sealed for life' and pressurised equipment must incorporate a pressure monitoring device. Only HV switchgear approved for use by Distribution Network Operators (DNO's) shall be used (i.e. complying with ENATS Standard 41-36).

Unless specified elsewhere RMUs shall have a minimum short-circuit withstand of 250 MVA for 3 seconds. The protection unit incorporated into the circuit breaker shall be as specified in the design drawings. If no detail is provided, refer to the project designer for clarification. Do not automatically assume that TLF protection will be adequate.

Where there is provision, Voltage Presence Indicators (VPIs) shall be fitted.

3.5 Metering

Metering and metering instrumentation shall comply with the relevant parts of:

- BS EN 60051 [series] (Direct acting indicating analogue electrical measuring instruments and their accessories.)

Where metering is used for billing purposes, meters and metering instruments shall comply with the relevant parts of:

- BS EN 62053 [series] (Electricity metering equipment (a.c.))

3.6 Tripping Batteries & Battery Chargers

Where a Battery trip unit is required the voltage shall be 24, 30, 48 or 110V taking account of the Switchboard trip coil voltage and open / closing coil voltage.

The Battery trip unit shall incorporate Sealed Lead Acid type Batteries with a design life of 10 years and an automatic constant voltage charger to provide 24 hour capacity followed by 6 No. complete Switching cycles of all HV Circuit Breakers within the Switchboard for the following functions whilst also allowing for any standing load.

- Intertripping
- Shunt Tripping
- Emergency Power off
- Closing / opening

Input shall be 230V and full recharge shall be achieved within 24 hours. Operating temperature range shall be -10°C +40°C

The Battery Cubicle shall be protected against ingress to IP42 external and IP2X internal

The unit shall incorporate AC supply voltage, battery voltage and charger current metering. Lamp indication for ‘Supply On’, ‘Supply Fail’ and ‘Battery Voltage Low’.

Transformers shall be double wound with earth screen to BS171

A common alarm output shall be provided for charger fail / output fail.

4 LV Switchgear

4.1 Main LV Switchboard(s)

4.1.1 General

Cubicle-type free standing, floor mounted, LV switchboards shall be constructed in accordance with BS EN 61439 and BS EN 60947, and have a short-circuit fault current withstand rating suitable to the maximum 3 phase RMS value attainable at the point of utilisation or 50kA for 1 sec (whichever is larger). They shall be suitable for use on a 400 / 230V (+10 / -6%) 50Hz, 3 phase, 4 wire supply and in an ambient temperature ranging between 0°C and 35°C.

Main switchboards shall generally be constructed to Form 4a – Type 2, with Form 4b – Type 6 construction for large outgoing cables. Classification of separation shall be as described in the National Annex NC to BS EN 61439.

Where the switchboard serves non-critical areas or services where its isolation would cause acceptable disruption, a lower specification may be considered.

Switchboards shall be top or bottom entry / exit and, depending on the application, front or rear access. Protective devices shall be mounted between 300 mm and 1800 mm above finished floor level. Switchboards shall have an overall maximum height of 2100 mm with adequate height above the switchboard for the bending radius of incoming/outgoing cables.

Each incoming and outgoing circuit on the switchboard shall be clearly identified on the front panel by means of an engraved label bearing the relevant information in black letters on a white background. The labels shall be Formica-type laminate with letters not less than 5 mm high.

Where rear access is available, labels shall also be fixed to the rear of the panels.

Warning labels shall be fitted in all places where the removal of covers or access panels may expose live equipment operating at above 250 volts between phases or to earth.

The labels shall be Formica-type laminate with red letters on a white background and shall typically be worded ‘Danger 400 volts. Isolate before removing’.

Small circuit test points shall be provided at main incomers to enable voltage and phase rotation checks, etc. to be carried out without removing main covers.

Where the switchboard is transformer supplied and the system is of the TN-S arrangement, a Neutral / Earth Link shall be provided within the main LV switchboard immediately upstream of the main incoming ACB. The Neutral / Earth link shall be in an accessible position and shall connect to the switchboard main earth bar.

Notes: Where Restricted Earth Fault (REF) protection is specified the Neutral CT must be upstream of N/E link. In some situations, where REF CTs are integral to the main ACB, the manufacturer shall advise on the most suitable location of the N/E link.

As a general rule REF protection is recommended where the transformer is 2MVA or larger, or where the transformer tails exceed 10m length.

4.1.2 Materials and Products

4.1.2.1 Cubicles

Enclosures shall be manufactured from heavy gauge sheet metal 1.6 mm minimum, with a minimum degree of protection to IP 31 for normal indoor applications.

Each shipping section shall be structurally stable for transit so that distortion of the component parts does not occur. Each section shall be provided with lifting eyebolts with suitable internal strengthening where necessary.

Cubicles shall incorporate a 100 mm (minimum) plinth to raise them above finished floor level.

Modular steel cases and framework shall be bonded to earth and all hinged covers shall be bonded to module cases.

Air inlets shall be provided to ensure adequate ventilation for heat dissipation.

4.1.2.2 **Busbars**

Switchboard busbars shall comply with the relevant parts of the following standard:

- BS EN 1439-6 (Low-voltage switchgear and controlgear assemblies. Busbar trunking systems [busways])

Busbars shall be manufactured from hard drawn copper and secured with insulated fixings. Fixings shall be designed to allow for thermal movement under normal conditions, in addition to withstanding the forces created under short-circuit fault conditions, without distortion.

Busbar assemblies shall be four pole, air insulated, with a continuous current rating suitable for the purpose of the installation. Phase and neutral busbars shall have the same rating. Where appropriate, busbars shall be arranged so that future extensions can be made using bolted links. All busbars shall have alpha-numerical identification, at reasonable intervals, to indicate phase, neutral and earth connections. E.g. L1; L2; L3; N; E.

All busbar connections and joints shall be accessible and not obstructed by section framework. At joints the busbars shall be rigidly bolted together and full allowance shall be made in the rating of the busbars and connections for reductions due to holes etc.

A separate copper earth bar shall run the entire length of each switchboard, adequately rated for the earth fault current at the main incomer.

The switchgear panel manufacturer shall ensure that all gland plates are directly bonded to the copper earth bar by an appropriately sized copper conductor.

The earth bar shall be sized in accordance with BS 7430 for the relevant prospective short-circuit current. The minimum size shall be 25 x 3 mm.

4.1.2.3 Protective Devices

4.1.2.3.1 Air Circuit Breakers (ACBs)

ACBs shall be manufactured to BS EN 60947 and, where used as incoming devices to main switchgear panels, shall be rated to the maximum prospective fault current of the supply transformer.

They shall be 3 pole with an accessible bolted neutral link, or 4 pole where specified. (4 pole switching/isolation may be required where Generator, UPS or PV systems are provided)

A test block shall be provided at the front of the unit to allow secondary injection testing of all relay and tripping circuits.

Small circuit test points shall be provided to enable voltage and phase rotation testing to be carried out without removal of fixed coverings.

ACBs shall be fixed or withdrawable pattern as shown / detailed on the main schematic diagram.

Withdrawable ACBs shall be horizontal draw-out pattern with full load current ratings for uninterrupted duty under standard service conditions.

They shall have automatic safety shutters for screening of fixed contact when the breaker is withdrawn from the 'service' position. Means shall be provided for padlocking both the busbar and feeder shutters in the closed position.

ACBs shall be provided with the following positively and mechanically identified positions:

'Service' - All main and secondary isolating contacts shall be made and, where a separate circuit breaker access door is provided, this shall be interlocked and held closed.

'Isolated' - The secondary contacts only shall be made to enable the circuit breaker to be operated for maintenance purposes and the access door shall be free.

'Withdrawn' - All supplies shall be isolated from the moving portion of the circuit breaker and, by operation of a mechanical latch or similar arrangement; the circuit breaker shall be capable of being disengaged from the racking mechanism and removed from its housing.

Padlocking facilities shall be provided to enable the ACB to be locked in any position.

Where ACBs are arranged for automatic operation, facilities shall be provided to lock off manual push buttons.

Withdrawable ACBs of the same rating shall be interchangeable whilst ACBs of a different rating, but having the same frame size, shall have a device for preventing insertion in the wrong housing.

ACBs used as incoming devices shall be fitted with protection units / devices as shown on the drawings. When insufficient detail is available the switchgear assembler / manufacturer shall ensure that the protection units / devices on the main incomer are able to discriminate fully with outgoing devices on the same panel up to the maximum service currents and prospective short-circuit levels.

Where the associated supply transformer is fitted with a winding temperature trip facility, the incoming ACB shall be equipped to receive the trip signal.

Where Restricted Earth Fault (REF) protection is specified, the switchgear assembler / manufacturer shall supply and install the appropriate current transformers and secondary wiring and equip the ACB with the necessary trip receive / trip send facilities.

4.1.2.3.2 **Moulded Case Circuit Breakers (MCCBs)**

MCCBs shall be manufactured to BS EN 60947. They shall be suitable for uninterrupted duty and shall have a short-circuit performance tested to the service short-circuit capacity.

All MCCBs shall be designed for horizontal or upright mounting without any adverse effect on electrical performance.

The operating mechanism shall be of the quick make / quick break type with the speed of operation independent of the operator, and mechanically trip free from the operating handle. The operating mechanism shall operate on all poles simultaneously.

The MCCB status shall be clearly indicated, i.e. ON – OFF – TRIPPED. Positive contact indication must be maintained, should the MCCB be enclosed or fitted with any operating accessory.

All accessories and electrical auxiliaries such as shunt trips, under-voltage releases, motor mechanisms etc. shall be manufactured in such a way as to allow easy installation, either at the manufacturer's works or on site.

4.1.2.3.3 **Automatic Changeover Contactors**

Automatic changeover contactors shall be of the 4-pole type comprising a pair of electrically and mechanically interlocked heavy duty contactors complying with BS EN 60947 Part 6, no-volt detection relay and control circuit protection fuses. All components shall be contained within a single enclosure having a degree of protection at least IP 31, suitably ventilated for heat dissipation and rated for category AC-3 operation.

Where the availability of supplies to life-safety and fire-fighting equipment is conditional to the occupation of the building, a maintenance bypass arrangement shall be provided. Refer to BS 8519 (clause 9)

4.1.2.3.4 **Switches and Fused Switches - General**

Automatic Switches and fused switches shall be manufactured to BS EN 60947-3.

All equipment shall be air-break type using a double break mechanism. It shall be of the appropriate utilisation category and class of duty for the application.

Equipment shall be de-rated as recommended by the manufacturers if environmental conditions fall outside the standard conditions defined in BS EN 60947-3. It shall be possible to carry out all routine maintenance and changing of fuses and contacts without disconnecting any cables or busbars.

Switches shall be switch disconnectors as defined in BS EN 60947-3. This means that when in the OPEN position the switch will satisfy the safety isolating requirements for disconnectors.

Switches shall be rated for uninterrupted duty and shall be capable of making, carrying continuously and breaking full-rated current.

Switches shall be capable of making full short-circuit current and carrying it for three seconds.

Fuse links shall be HRC bolt-on type to BS EN 60269-1. The particular type of fuse, the fuse rating and the characteristics shall be as shown in the main schematic diagram. Where the fused switch is an outgoing way, the switchgear assembler / manufacturer shall check that the proposed fuse size / type is compatible for discrimination purposes with the main incoming device.

Where the fused switch is to be used as a main incoming device, the switchgear assembler / manufacturer shall ensure that it is capable of carrying the full load continuously without deterioration of the contacts, connections or component parts.

4.1.3 Power Factor Correction

Power Factor correction capacitors shall be manufactured and tested in accordance with the relevant parts of

- BS EN 60831 (Shunt power capacitors, self-healing type)
- BS EN 61921 (Power capacitors. Low-voltage power factor correction banks)

Power factor correction shall be fitted either at each individual item of equipment or included within the main or sub-main distribution switchboards.

Where Power factor correction is included within the main switchboard (bulk correction) the size of individually switched capacitor banks shall be matched to suit the switching and arrangement of electrical loads being supplied by the switchboard.

Power Factor correction capacitors shall be rated at 480V.

Where high harmonic distortion is present on the downstream electrical network, series tuned reactors shall be fitted to protect and enhance the life of the PFC capacitors. The switchgear manufacturer shall be consulted in relation to series tuned reactor selection.

Bulk or central power factor correction capacitors shall automatically be isolated from the distribution system in the event of a mains supply failure.

4.1.4 Life Safety Supplies

Where the Main LV Switchboard supplies power to “Life Safety” or “Fire Equipment” a dedicated section of the switchboard supplied from **Live** side of the main incoming isolator should be provided. Each protective device on this section of the switchboard should be capable of being locked in the “ON” position and clearly labelled “Warning: this supply remains live when the main switch is turned off”

A label should be placed on the main switchboard isolating device stating:

“WARNING: CIRCUITS (*list ‘life safety’ and ‘fire equipment’ circuits*) REMAIN LIVE WHEN THIS SWITCH IS TURNED OFF”.

Where the fire equipment is an electric sprinkler pump the protective device shall be a suitably rated BS88 fused switch.

4.1.5 Fire Alarm System Supply

The supply to the main fire alarm panel should be independent of all other supplies and the switchboard housing door should be coloured signal red and labelled;

“FIRE ALARM SYSTEM, DO NOT SWITCH OFF”

4.2 Sub-Distribution Panel Boards

4.2.1 General

Wall mounted panel boards, also known as ‘section boards’, typically comprise of MCCB outgoing ways, in the range of 125 to 400 A and having a 400 to 800 A non-auto incoming device.

Where such panel boards are utilised, extension side boxes and / or bottom boxes shall be employed as necessary to maintain sufficient cable bending radiuses.

Form 4a, type 2 shall be maintained within the panel board, by means of proprietary rigid plastic shrouds, fitted to the outgoing terminals of the MCCB’s.

4.3 Distribution Boards

4.3.1 General

Three-phase and single phase final circuit distribution boards shall be constructed in accordance with BS EN 61439 and BS EN 60947.

Single phase distribution boards (and consumer units) shall have a minimum short-circuit rating of 16kA, and a minimum busbar rating of 125A.

Three phase distribution boards shall have a minimum short-circuit rating of 25kA, and a minimum busbar rating of 250A.

Three phase and single phase distribution boards shall be suitable for use on a 400 / 230V (+10 / -6%) 50Hz electrical supply.

Three phase and single phase distribution boards shall have a minimum IP3X degree of protection and be suitable for operation in ambient temperatures up to +35°C

Three phase and single phase distribution boards shall have insulated or fully encapsulated busbar systems and fully shrouded neutral bars and connections.

Three phase and single phase distribution boards shall have hinged lockable doors.

Three phase distribution boards shall accommodate an integral Isolator, MCCB or Residual current device. Incoming devices shall be suitable for isolation and capable of being padlocked in the ‘OFF’ position.

Three phase distribution boards shall have removable gland plates and be capable of accommodating top and/or bottom extension boxes.

Neutral bars shall contain one terminal for each outgoing single-phase circuit identified to correlate with each outgoing phase/circuit.

Where the distribution board serves ring final circuit arrangements, It shall be possible to fit additional earth terminal connections to allow separate termination of each leg of the ring final circuit cables.

4.3.2 Workmanship / Installation

Distribution boards shall be mounted level and securely fixed to the supporting structure, wall or framework at an appropriate height with sufficient space in front to work on and access the distribution board.

Notes: The overall dimensions of distribution boards can vary greatly. Generally, if the main integral isolator is positioned 1200mm AFFL then the main MCB section will be readily accessible without access equipment. Distribution boards should have a clear 1m zone in front for access. Where it is not possible to provide a clear 1m zone, this may be reduced following a risk assessment.

Where trunking connects/interfaces with distribution boards is shall be securely and neatly installed using one of the following methods:

- A Slotted insulator shall be sandwiched between the distribution board glandplates(s) and Trunking. The slots in the trunking and the distribution board glandplate shall be larger than that of the insulator. All cut edges shall be neat and tidy, fully deburred and protected from corrosion.
- A proprietary flange shall be fitted in accordance with the manufacturer's instructions.
- The trunking is connected to the distribution board using bushes and locknuts. Where this method is used all cables of a particular circuit must pass through the same bush/locknut.

Regardless of the method used, the distribution board epoxy paint shall be removed around the fixings to ensure a sound electrical connection between the distribution board and trunking

Each distribution board shall have a unique reference engraved on a traffolyte label securely fixed to the distribution board with nuts and bolts. The label shall also contain any other specific supply characteristics such as "Essential", "Non-Essential", "UPS Supply". Traffolyte labels shall have a white background with black engraved letters. The main DB reference text shall be a minimum of 20mm high.

Specified Distribution Board spare capacities shall be calculated based on the number of circuits defined within the distribution board schedules at the time the distribution boards are procured (i.e. a 12 way TP&N DB with 6 TP&N ways used has 100% spare capacity). Where spare capacities are required in the distribution board, an equivalent spare capacity shall be included within the distribution board supply cable.

Each distribution board shall be provided with a completed circuit chart/schedule inserted in a transparent plastic wallet secured to the inside of the distribution board door.

All unused ways shall be fitted with manufacturers proprietary blanking plates

4.3.3 Miniature Circuit Breakers (MCB's)

MCBs shall comply with BS EN 60898 and BS EN 60947-2.

MCBs shall be suitable for industrial isolation according to BS EN 60947 parts 2 and 3, with positive ON – OFF contact indication

MCBs shall protect against both overload and short circuit currents.

MCBs shall have an Icu short circuit withstand rating not less than the PSCC calculated or measured at the distribution board Incoming terminals or 15kA (whichever is larger)

MCB incoming and outgoing electrical connections shall be terminated in accordance with manufacturers guidance and specified torque settings.

4.3.4 HRC Fuses

Cartridge fuse links, fuse carriers, bases and associated parts shall comply with BS EN 60269-1 / BS 88-1

Unless otherwise indicated BS EN 60269 fuse links shall be class gC

4.3.5 Residual Current Devices (RCCBs and RCBOs)

Residual current devices shall comply with BS EN 61008-1 (RCCBs) or BS EN 61009-1 (RCBOs) as appropriate. The RCD type, rated voltage, current, tripping current and breaking capacity shall be as indicated.

Where RCDs are required, and the nature and characteristics of a load are not known or cannot be determined “type B” RCDs shall be used.

Unless otherwise specified the tripping current and characteristic of RCDs protecting final circuits shall be 30mA with instantaneous trip.

4.3.6 Arc Fault Detection Devices (AFDDs)

Arc fault detection devices shall comply with BS EN 62606.

If used AFDDs shall be fitted at the origin of the circuit to be protected.

The decision as to whether AFDDs are installed to protect against the risk of fire(s) being caused by electrical arc faults should be made and agreed jointly by the following parties:

- The client / employer
- The client’s or project insurer
- The project fire engineering consultant
- The building control officer / fire authority
- The building services engineer / consultant

4.4 Workmanship (LV Switchgear)

4.4.1 General

All switchgear panels and components shall be fixed independent of wiring and cabling systems.

Proprietary fixings shall be employed to rigidly fix the panels / devices to walls or floor as appropriate.

Ensure that when fixed in position the clearance in front of the switchgear, including any withdrawn circuit breakers, hinged doors etc. is not less than one metre.

Where the switchgear panel is supplied in sections, tighten busbar joints and connections with a torque spanner in accordance with the manufacturer's recommendations.

Number terminals, cables and component parts shall correspond with manufacturer's certified drawings.

Bond the switchgear earth bar to the main earth bar as detailed in Section 9 of this specification.

4.4.2 Testing

Type-tested switchgear assemblies shall be certified by an approved testing authority as having passed short-circuit testing in accordance with BS EN 61439-2.

All switchgear shall be so designed and constructed that it will withstand for the specified time period without damage the thermal and mechanical stresses which might arise under short-circuit conditions up to the prospective busbar short-circuit currents.

An over-voltage pressure test shall be carried out with all protective devices closed and power fuses fitted, but having control circuits disconnected. The panels shall withstand for one minute a pressure of 2 kV across the following:

phase to phase;
phase to neutral;
phase to earth;
neutral to earth.

An insulation resistance test shall be made immediately following the pressure test using a 500V instrument. The test shall be made with all protective devices closed and power fuses fitted, but having all electronic components and control equipment likely to suffer damage under test, removed. An insulation resistance of not less than 20 mega-ohms shall be obtained between each of the points listed above.

Manufacturers' test certificates shall be provided for all components and items of equipment installed within the switchgear panel, including those for protective devices.

Secondary injection test at service settings shall be carried out on site to prove tripping, etc (including injection tests to prove the correct polarity of E/F external neutral CTs)

Simulated testing shall be carried out on site to prove all inter-trip functions etc.

Where the LV panel has an alternative supply provision, i.e. a stand-by generator, tests shall be carried out on site to simulate loss of mains supply and prove changeover to alternative supply conditions. This test shall be followed by proving changeover back to mains supply on restoration of same.

Functional tests shall be performed to verify the correct set up, operation and functioning of any: motorised switchgear, contactors, PFC controllers, load stepping/load shedding controls, instruments & metering and BMS outputs and alarms.

Where alternative supply changeover systems rely on manual castell interlocks the changeover process and methodology shall be tested and proven on site.

All adjustable overcurrent, earth fault and residual earth fault protection settings for ACBs and MCCBs shall be in accordance with the system designer's reports and schedules.

5 UPS & Emergency Standby Systems

5.1 Uninterruptible Power Supplies (UPS)

5.1.1 General

UPS systems shall be manufactured, installed and performance tested in accordance with relevant parts of the following standards:

- BS EN 62040-1 (Uninterruptible power systems (UPS). General and safety requirements for UPS)
- BS EN 62040-1-1 (Uninterruptible power systems (UPS). General and safety requirements for UPS used in operator access areas
- BS EN 62040-1-2 (Uninterruptible power systems (UPS). General and safety requirements for UPS used in restricted access locations
- BS EN 62040-2 (Uninterruptible power systems (UPS). Electromagnetic compatibility (EMC) requirements)
- BS EN 62040-3 (Uninterruptible power systems (UPS). Method of specifying the performance and test requirements)
- BS EN 62040-4 (Uninterruptible power systems (UPS). Environmental aspects. Requirements and reporting)
- BS EN 62040-5-3 (Uninterruptible power systems (UPS). DC output UPS. Performance and test requirements)

Depending on the UPS configuration it may be required to maintain an uninterrupted Neutral / Earth link at the main LV switchboard. Such links can be isolated from the UPS (often for short periods) where 4 pole switching is employed as part of a resilient supply arrangement. Loss of the N/E link momentarily can result in the opening of any RCBO's downstream of the UPS.

Where it is necessary to limit the amount of harmonic distortion upstream of the UPS, minimum 12 pulse rectification shall be employed.

Where specified/required, the UPS configuration shall include no-break maintenance by-pass provisions to enable all UPS system components to be maintained or replaced. The project specific electrical specification shall detail the specific by-pass configuration arrangements.

The UPS system shall incorporate volt-free contacts for connection to a Building Management System (BMS) or other monitoring system. As a minimum the outputs shall include:

- Mains supply healthy
- Temperature alarm
- Battery charge low
- UPS System common fault
- Bypass status

The project specific electrical specification shall detail the required UPS battery type and required lifespan. Batteries shall be installed and maintained inline with manufacturers recommendations and in accordance with BS EN 62040.

5.2 Standby Power Supplies for Emergency Lighting Systems

5.2.1 General

Standby central power supply systems for essential services shall meet the requirements of the following standard:

- BS EN 50171 (Central power systems)

Batteries for use in Emergency Lighting central battery systems shall have a declared life expectancy of at least 10 years (when maintained at an ambient temperature of 20°C)

Central power system battery ratings shall refer to the “Design Life” of the batteries not the “End of Life” rating.

Unless otherwise specified, the ‘Auto Transfer Switch’ configuration associated with the central power/battery system shall be ‘Single line Bypass’.

Emergency Lighting central battery systems shall be separated from the main electrical intake switchroom and be located in an area of low fire risk.

5.3 Batteries

5.3.1 General

Batteries for UPS and Central Battery Systems shall be manufactured, certified, installed, tested and maintained in accordance with the relevant parts of the following standards:

- BS EN 60896-11 (Stationary lead-acid batteries. General requirements and methods of test. Vented types. General requirements and methods of tests)
- BS EN 60896-21 (Stationary lead-acid batteries. Valve regulated types. Methods of test)

- BS EN 60896-22 (Stationary lead-acid batteries. Valve regulated types. Requirements)
- BS EN IEC 62485-1 (Safety requirements for secondary batteries and battery installations. General safety information)
- BS EN IEC 62485-2 (Safety requirements for secondary batteries and battery installations. Stationary batteries)
- BS EN IEC 62485-4 (Safety requirements for secondary batteries and battery installations. Valve-regulated lead-acid batteries for use in portable appliances)
- BS EN 62259 (Secondary cells and batteries containing alkaline or other non-acid electrolytes. Nickel-cadmium prismatic secondary single cells with partial gas recombination)
- BS EN 60623 (Secondary cells and batteries containing alkaline or other non-acid electrolytes. Vented nickel-cadmium prismatic rechargeable single cells)
- BS EN IEC 62485-5 (Safety requirements for secondary batteries and battery installations. Part 5. Lithium-ion batteries for stationary applications)

Attention is drawn to the “Waste Batteries and Accumulators Regulations 2009” concerning the disposal and recycling of batteries at the end of their service life.

5.3.2 Battery Types

The battery requirements for UPS’s & Emergency Standby Systems will vary depending on the particular project requirements and the level of integration with other systems. Below are the key features of each battery type that will influence the final selection.

1. **Lead Acid Batteries:** The two main types of lead acid battery are:
    - **Valve Regulated Lead Acid (VRLA):** VRLA batteries are sealed and can be mounted in any orientation. They are the most common type of battery in use for standby systems with a typical life of around 5 years. VRLA batteries are reliable, have low maintenance requirements and a lower initial cost than other battery types. They must be stored at room temperature in a ventilated, dry climate controlled room/enclosure. There are two main types of VRLA batteries distinguished by the composition of the electrolyte, these are:
        - AGM – Absorbed Glass Material, electrolyte is held within pourous microfiber glass separator.
        - GEL – A electrolyte gel made form a mixture of sulphuric acid and silica
    - **Vented/Lead Acid (VLA):** Vented or Flooded type LA batteries provide higher reliability and a longer lifespan (up to 20 years) than vented type batteries, but have higher maintenance, stricter ventilation requirements and higher initial cost than VRLA type batteries.
2. **Nickel Cadmium (NiCd):** – Nickel Cadmium batteries have a long lifespan (typically 20 years) they can cope with temperature extremes (-20°C to +40°C) and can also tolerate harsh charge and discharge cycles. NiCd batteries cost much more than VRLA equivalents.
3. **Lithium Ion (LIB):** – Lithium Ion batteries are smaller and lighter than other battery types per Ah, have high charge and discharge times, operate at higher ambient temperatures and can have built-in management and monitoring. They have lower operational costs due to less frequent maintenance and replacement, but are typically 40% more expensive than Nickel Cadmium cells.

Where a dedicated room/enclosure is provided to house batteries for standby electrical supplies the following warning notice shall be displayed on all entry doors "BATTERY ROOM. EXTINGUISH ALL NAKED LIGHTS BEFORE ENTERING. NO SMOKING"

5.3.3 Battery Ventilation

Irrespective of battery type, the enclose/room in which they are housed must be ventilated in accordance with BS EN IEC 62485-2

5.4 Rotary UPS Systems

Rotary UPS systems shall be detailed on a project by project basis in a comprehensive project specific specification.

6 Cables

6.1 Cables

6.1.1 General

Use new cables, delivered to site with seals intact, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture.

All cables shall conform to third-party certification / inspection / testing of product conformity with the relevant British Standard.

All cables to be marked with CENELEC cable certification marking or, if included in British Approvals Service for Cables (BASEC), in accordance with BASEC regulations.

All fire-resistant cables supplying life safety and emergency systems shall be LPCB certified

6.1.2 Construction Product Regulations (CPR)

Under the CPR regulations a "Declaration of Conformity" must be provided for each type/batch of cable by the manufacturer or supplier.

CPR Regulations only stipulate that all cables must be classified for their reaction to fire, they do not stipulate the minimum class of performance that should be used in an installation. The UK government has stated it does not intend to mandate minimum standards in the UK.

In relation to fire performance and reaction to fire, and for the purpose of this specification, cables installed on NG Bailey projects fall into one or more of the following groups:

Group 1 - General cables: fixed power, control and data cables supplying systems and services not intended for continued use in the event of a fire, and installed in a manner where the potential risk of flame propagation is low.

Group 2 - General cables: fixed power, control and data cables installed within, or passing through the fire compartment of a dedicated or defined escape route, or where the risk of flame propagation is high.
Group 3 - Fire resistant cables: supplying 'critical' or 'life safety systems' that are required to resist the effects of fire for a defined period.

In the absence of mandated minimum Euroclass criteria in the UK, the only requirement under the Construction Product Regulations in relation to cables is that they are provided with a declaration of conformity for a particular Euroclass code. As the Euroclass codes do not align with current UK requirements, at the time of writing the industry is continuing to adopt existing UK standards. Therefore, all cables being installed on NG Bailey projects must as a minimum:

- meet the requirements of BS EN 60332-1-2 (This is directly equivalent to Euroclass classification of E_{ca})
- satisfy the requirements below for the particular cable application.
- For telecommunication cables installed in pathways below floors, above ceilings or behind walls, a minimum Euroclass C_{ca} -s1b,d2,a2 in accordance with BS EN 13506-6.

Where cables are installed within a fire-segregated compartment that forms part of an emergency escape route they shall meet the requirements of the relevant parts of:

- BS EN 60332-3 series achieving at least 60% light transmittance when tested in accordance with BS EN 61034-2 (for Power & Control cables)

Under the Construction Product Regulations (CPR), cables are classified in 7 Euroclasses according to their contribution to fire. Additional criteria define smoke production, burning droplets and acidity.

Eurolcass code = Euroclass (+ Smoke Production + Burning Droplets + Acidity)

Table 6.1 Euroclass Codes (refer to BS EN 13501-6)

Euroclass	Contribution to Fire	Tested in accordance with:
A_{ca}	No Reaction	EN ISO 1716
$B1_{ca}$	Very low reaction	EN 60332-1-2 & EN 50399 (30kW source)
$B2_{ca}$	Low reaction	EN 60332-1-2 & EN 50399 (20.5kW source)
C_{ca}	Reduced reaction	EN 60332-1-2 & EN 50399 (20.5kW source)
D_{ca}	Average reaction	EN 60332-1-2 & EN 50399 (20.5kW source)
E_{ca}	High reaction	EN 60332-1-2
F_{ca}	Undetermined	

Table 6.2 Additional Criteria (relevant to classes $B1_{ca}$, $B2_{ca}$, C_{ca} & D_{ca})

Smoke Production		Burning Droplets		Acidity	
s1	Low	**d0**	None	**a1**	Low
$s1_a$	Low + light transmission > 80%	**d1**	Average	**a2**	Limited
$s1_b$	Low + light transmission > 60%	**d2**	Worst	**a3**	Worst
s2	Average				
s3	Worst				

6.1.3 Common Cable British & European Standards Listing (Summary)

BS 6622:2007 – 3.8/6.6 kV to 19/33 kV, Armoured, XLPE
BS 7835:2007 – 3.8/6.6 kV to 19/33 kV, Armoured, XLPE, LSF
BS 5467:2016 – 600/1000 V, Armoured, XLPE
BS 6724:2016 – 600/1000 V, Armoured, XLPE, LSF
BS 7846:2015 – 600/1000 V, Armoured, XLPE, LSF, Fire Resistant
BS 7629-1:2015 – 300/500 Multicore Screened, LSF, Fire Resistant
BS EN 60702-1:2002+A1:2015 – Mineral Insulated Cables not exceeding 750 V
BS 7889:2012 – 600/1000 V, Non-armoured, XLPE Insulated, PVC Sheath
BS 8573:2012 – 600/1000 V, Non-armoured, XLPE Insulated, LSF Sheath
BS 6004:2102 – 300/500 V, PVC Insulated, PVC Sheathed (T&E)
BS 7211:2012 – 450/750 V, LSZH Insulated, LSF Sheathed (T&E)
BS 7870-4.10:2011+A1:2016 – 11/33 kV, LV & MV Polymeric insulted
BS 6387:2014 – Test Methods for resistance to fire of Cables
BS 8434-2:2003+A2:2009 – Test Methods of the Fire Integrity of Cables
BS EN 50200:2015 - Test Methods for resistance to fire of Cables
BS EN 50363-5:2005 – Insulation, sheathing and covering materials ZH

6.1.4 High Voltage Distribution Cables

HV (11 kV) cables shall conform to BS 6622 or BS 7835. Aluminum or Copper, Triplex Utility cables to BS 7870-4 shall only be installed where client or DNO requirements dictate the use of Triplex cables.

Keep records of HV (above 1 kV) cable drum numbers and supporting information, mark information on record drawings, indicating precise location and each length of cable. Include copies of manufacturer's cable test certificate(s) in O & M manual.

6.1.5 Low Voltage Distribution Cables

LV (up to 1000v) cables shall conform to BS 6724 (XLPE LSF) or BS 5467 (XLPE).

6.1.6 Final Circuit Cables

Cables supplying fixed wiring final circuits shall be selected to suit the manufacturers intended application and installation method.

All final circuit cables supplying fixed wiring shall comply with an appropriate British or European Standard.

Table 6.3 – Approved Cable types for Common Installation methods

Service	Installation Method(s)	Cable Type , Product Name	Applicable Standards	Certification(s)
Small Power & Lighting	Trunking, Conduit	Thermosetting Singles 6491B	BS 7211, HO7Z-R	BASEC
Small Power & Lighting	Modular Wiring (Flexible Conduit System)	Thermosetting Singles 6491B	BS 7211, HO7Z-R	BASEC
Small Power & Lighting	Modular Wiring (Sheathed Cable System)		BS 8488	
Small Power & Lighting (Sheathed T&E)	Tray/Ladder Clipped Direct Embedded	T&E 6242BH	BS 7211	BASEC
Small Power & Lighting (Flexible Connection to Final Equipment)	Clipped Direct, Free Air	Flex		
Small Power Panel Wiring	Enclosed Panel Wiring		Tri-rated Singles, 2491B/6701B	BS 7211 Table 3 & 4b, CENELEC HD22.9, BS EN 50525-3-41, IEC 60332-3-24, IEC 60754-1 & 2 BS EN 50267-2-1 & 2, BS EN / IEC 61034-1
Fire Alarm Cabling (Standard classification)	Basket, Tray, Trunking, Clipped Direct	Fire Resisting PH 30	BS 7629-1 or BS 7846, BS EN 60702-1, BS EN 50200, BS 8434-2	LCPB, BASEC
Fire Alarm Cable (Enhanced classification)	Basket, Tray, Trunking, Clipped Direct	Fire Resisting PH 120	BS 7629-1 or BS 7846, BS EN 60702-1, BS EN 50200, BS 8434-2	LCPB, BASEC
Emergency Lighting Cable, Central Battery System (Final Circuit)	Tray, Basket, Clipped Direct	Fire Resisting PH 60	BS 7629-1, BS 7846, BS EN 60702-1, BS EN 50200	LCPB, BASEC
Emergency Lighting Cable, Central Battery System (Final Circuit Enhanced)	Tray, Basket, Clipped Direct	Fire Resisting PH 120	BS 7629-1, BS 7846, BS EN 60702-1, BS EN 50200, BS 8434-2	LCPB, BASEC
Emergency Lighting (Sub-main Cables)	Tray, Ladder, Clipped Direct	Fire Resisting PH 60		
LV Power & Submain Cabling (Single Core Armoured)	Tray, Ladder, Clipped Direct	XLPE/AWA/LSF	BS 6724	BASEC

LV Power & Submain Cabling (Multicore Armoured)	External Trench, Ducted	XLPE/AWA/LSF	BS 6724	BASEC
LV Power & Submain Cabling	External Trench, Ducted	XLPE/AWA/PVC	BS 6724	BASEC
HV Power Cabling (to 11kV)	Internal Ladder, Internal Tray		BS 6622, BS EN 60228	BASEC
HV Power Cabling	External Trench, Ducted		BS 6622, BS EN 60228	
BMS Controls, (Actuators, Motors/Servo-motors using VSDs)	Trunking, Conduit, Cable Tray/Basket	Eland Veriflex 2XSLCH LSZH Servo Cable. (up to 6sqmm)	BS EN/IEC 60228, DIN EN 50267-2, EN IEC 61034-1/2, EN IEC 60754-1/2	BSI
BMS Control, monitoring	Trunking, Conduit, Cable Tray/Basket	Eland Veriflex Screened Bedded LSZH Cable. (up to 6sqmm)	VDE 0295, VDE 0207-303-7, VDE 0293-308, VDE 0482-332-1-2, VDE 0819-102, EN IEC 61034-1, EN IEC 60754-1/2	BSI
Data Communications	Trunking, Conduit, Cable Tray/Basket, Raceway	Cat 5e, 6, 6a LSZH	EN 50173-1, TIA/EIA 568-C.2, ISO/IEC 11801	

6.2 Cable Jointing, Terminating & Identification

6.2.1 Cable Terminations General

Ensure all joints and terminations are made by appropriately electrically skilled persons or qualified cable jointers, using materials, components and workmanship recommended by the cable manufacturer and the jointing accessory manufacturer.

Select and install cable glands in accordance with BS 6121-5:2005.

Cold pour resin and heat shrink joints to be in accordance with BS EN 50655-1:2007

All compression (crimp) type cable termination lugs and the associated tooling shall be selected (in consultation with the relevant manufacturers) to ensure full compatibility between lug, crimp tool and cable. All crimp tooling shall be maintained and calibrated to ensure the performance of all crimps meets with the requirements of the relevant parts of BS EN 61238-1.

All compression type, crimped connections shall be installed and inspected in accordance with BS 7609:1992+A2:2009

6.2.2 HV Cable Terminations

All HV cable terminations and associated accessories shall meet the required performance when tested in accordance with BS EN 61442

HV cable termination kits shall be of the heat shrink type, in accordance with BS 7888 and shall be approved by the cable manufacturer and switchgear manufacturer for compatibility with their respective equipment. Where required, at final terminations, cold applied, silicone rubber bushing boots (sealing sleeves) shall be applied, to enable disconnection of the terminations. Where required screened separable connectors shall be used, matched to the switchgear manufacturers details.

Ensure all joints and terminations are made by appropriately qualified and experienced cable jointers. Use materials, components and workmanship recommended by the cable manufacturer and the jointing accessory manufacturer.

HV cable glanding to equipment(s) shall preferably be by means of the 'top hat' welded earth stud type, suitable for heat shrink terminations.

Form all compression connections to components using tools that cannot be released unless the correct degree of compression has been achieved. Install and inspect compression and mechanical connectors on conductors in accordance with BS 7609:1992+A2:2009 (Code of practice for installation and inspection of uninsulated compression and mechanical connectors for power cables with copper or aluminum conductors).

Bolt core terminations with lugs to equipment using washers or proprietary shake-proof devices.

6.2.3 LV SWA Cable Terminations

LV SWA cable glands shall be manufactured, tested and selected in accordance with the relevant parts of BS 6121.

LV SWA glands shall be supplied with LSZH (Low Smoke Zero Halogen) shrouds.

All LV SWA cable glands shall be fitted with brass earth tags or proprietary earthing nut.

6.2.4 MICC Terminations

MICC cables/terminations shall comply with the relevant parts of BS EN 60702.

Joint MICC cables using methods and materials recommended by the cable manufacturer. Terminate cables in externally threaded glands using seals with temperature rating indicated. Join conductors using crimped connectors.

Insulate connectors using PVC tape to BS EN 60454, ensuring a good seal to conductor sleeving. Make off glands into either end of internally threaded brass sleeve of correct size. Protect brass sleeve using heat shrink sleeving.

Terminate MICC cables in accordance with BS EN 60702-2 using components and materials recommended or supplied by the cable manufacturer.

Use seals with maximum temperature rating indicated, stub caps to the largest size available and drilled caps and headed sleeves for larger sizes.

Use glands as recommended by the cable manufacturer.

At termination to accessory boxes within a plaster or render finish, cable clamps fixed to accessory boxes and firmly gripping the cable sheath may be used. Use earth tail seals with sheath grip type accessory boxes.

At equipment not provided with threaded entries, secure glands using lock washers and lock nuts or brass conduit bushes. Use gland shrouds when sheathed MICC cables are used. Use PVC, PIB or LSF material tape to BS EN 60454 to match sheath, tape overall gland, any bare copper sheath and form seal to cable sheath under all shrouds.

Mark core sleeving with appropriate identification.

Install voltage surge compressors in accordance with manufacturer's recommendations when required.

Where MICC cables and accessories are installed in hazardous areas and locations, all products and installation methods must meet ATEX requirements.

6.2.5 Communications and IT Cable Terminations (Horizontal Distribution)

Use methods approved by cable and accessory manufacturers.

Employ labour certified by acceptable body as qualified to install and make joints and terminations in the referenced cable. Obtain approval of the cable manufacturer for accessories not supplied by them.

Identify cables using structured numbering system.

Unless otherwise specified all terminations will follow the EIA/TIA 568B configuration.

Maintain the twists of pared cables as close as possible to the point of termination, no more than 12mm of cable shall be left untwisted.

Refer to NG Bailey IT Services "Customer Delivery Manual Vol 1 2017/2018" for detailed data cable termination and installation.

6.2.6 Cable Identification

As a minimum main and sub-main cables shall be identified at either end (approx. 100mm from the cable gland) using proprietary cable marker labels.

6.3 Prefabricated Modular Wiring Systems

6.3.1 General

Prefabricated modular wiring systems form part of the 'Fixed Wiring' of an electrical installation.

Prefabricated wiring systems shall be manufactured and tested in accordance with:

- BS 8488 (Prefabricated wiring systems intended for permanent connection in fixed installations)

All cables used within modular wiring systems shall be classed as low smoke zero halogens (LSZH) and comply with the relevant parts of:

- BS EN 50525 (Low voltage energy cables up to 750v, low smoke zero halogen)

All accessories that form part of the modular wiring system shall comply with:

- BS 5733 (General requirements for electrical accessories. Specification)
- BS EN 61535 (Installation couplers intended for permanent connection in fixed installations)

Only cables manufactured in accordance with a BS or BS EN standard shall be used for the wiring of a prefabricated system.

All cables/circuits used within a modular wiring system shall be selected, sized and tested in accordance with BS 7671.

All circuits within flexible conduit type prefabricated wiring systems with contain separate, suitably sized CPCs.

Flexible cables & conduits that form part of the modular wiring system shall be suitably supported and restrained throughout their entire lengths.

7 Power & Lighting Busbar Systems

7.1 Distribution Busbar

7.1.1 General

Busbar trunking systems shall be designed, manufactured and tested in accordance with BS EN 61439-1 and BS EN 61439-6.

The application and use of busbar trunking systems shall adhere to the requirements and recommendations set out in BS 7671 (IET wiring regulations)

Busbar trunking will be designed and manufactured for use on a 400V/230V, 50Hz supply system.

Busbar trunking system fault ratings shall be greater than the maximum PSCC that can exist on any part of the busbar system under all switching and mains/standby supply configurations.

All busbar trunking components and accessories shall be manufactured by the same manufacturer as the busbar trunking.

Busbar joints shall be assembled in-line with manufacturers instructions and all connecting nuts and bolts shall be tightened to the correct torque values.

Three phase busbar trunking systems shall be 4 pole with a fully rated neutral conductor. Where specified the busbar may contain dedicated CPC conductor.

Busbar systems with tap-off outlet positions shall be of the plug in type, with automatic shutters that open only when the tap-off unit is inserted.

Busbar conductors shall be either Aluminium (Al) or Copper (Cu) as specified by the designer.

Note: Where busbar conductors are required to be plated or coated, advice shall be sought from the busbar manufacturer on the options available. The manufacturer shall be asked specifically about avoiding and mitigating the risk of the phenomena known as “Tin Whiskers”. The manufacturer’s recommendations where possible shall be discussed with the customer prior to procuring the busbar system(s).

Unless otherwise specified busbar systems shall have a minimum Ingress Protection rating of IP55.

Where busbar trunkings pass through fire rated walls or floors, proprietary passive fire stopping sections supplied from the busbar manufacturer shall be installed.

Busbar trunkings shall be supported in line with manufacturers recommendations.

Busbar trunking expansion requirements shall be fitted inline with manufacturers instructions. Any required anchor points shall be agreed with and confirmed by the project structural engineer.

7.1.2 Cable Feeder

Busbar End-feed or Middle-feed connection units shall be fitted with spreader boxes suitably sized to accommodate the actual size and number of supply cables.

Busbar End-feed or Middle-feed connection units shall be clearly labelled with the supply circuit reference and switch room reference.

Busbar End-feed or Middle-feed connection units shall clearly identify the order of the phase connections onto the busbar.

Unless otherwise specified, busbar feeder units shall incorporate an isolating device.

Busbar feeder units shall have a minimum ingress protection rating of IP55 unless otherwise specified

7.1.3 Tap-off Units

Use only Tap-off units designed and manufactured to fit the specific busbar system.

Tap-off units shall be securely fixed to the busbar in-line with the manufacturer's instructions.

All tap-off units shall have door interlocked isolation devices to prevent opening of the door, and also mechanically interlocked to prevent removal of the tap-off whilst the unit is live. Tap-off unit isolators or protective devices shall be capable of being locked in the 'OFF' position.

Tap-off units shall have stubs to prevent mis-alignment or incorrect insertion of the tap-off unit. The earth stub shall establish contact prior to the phase and neutral conductors.

Tap-off units shall only be fitted to busbar tap-off locations which allow for sufficient access to the tap-off.

Tap-off units shall be clearly labelled to identify the distribution board or item they supply, and indicate the size/rating of the protective device or fuses.

Tap-off cubicles shall incorporate removable gland plates suitable for terminating SWA cables or flexible/rigid conduits/trunking.

Busbar tap-off units shall have a minimum ingress protection rating of IP55 unless otherwise specified

7.2 Powertrack Busbar Trunking

7.2.1 General

Powertrack busbar systems shall be manufactured and tested in accordance with the following standards:

- BS EN 61534-1 (Powertrack systems. General Requirements)
- BS EN 61534-21 (Powertrack systems. Particular requirements for powertrack systems intended for wall and ceiling mounting)
- BS EN 61534-22 (Powertrack systems. Particular requirements for powertrack systems intended for onfloor or underfloor installation)

All Powertrack components and fittings shall be supplied form the same manufacturer as the busbar.

Unless otherwise specified connection to the busbar shall be via fused plug and socket. Plug and sockets shall be of a non-standard type.

8 Cable Containment and Support Systems

8.1 General Requirements

8.1.1 Supports & Fixings

8.1.1.1 This section is to be read in conjunction with NG Bailey Supports and Fixings Policy. Supports and Fixings for all electrical containment systems, including multi-service brackets and prefabricated modules shall be selected and supplied by NG Bailey approved fixing suppliers/specialists

It is the responsibility of NG Bailey Project Managers/Project Engineers to:

- Provide accurate total combined weight(s) of the services being suspended including any required spare capacities to both the fixing supplier/specialist and the project structural engineer (weights provided by NG Bailey will NOT include any additional allowances for safety factors)
- Provide details of the building structure (concrete, substrate, steelwork etc.) in which the fixing will be embedded, hung or secured to the approved fixing supplier/specialist.
- State whether the fixing/bracket arrangement is required to maintain performance under fire conditions.

It is the responsibility of the NG Bailey fixing specialist to:

- Select an appropriate cost effective fixing for the particular application
- Include the necessary allowances for “safety factors”
- Satisfy themselves that the information provided by NG Bailey relating to the building structure is suitable and adequate to make the correct fixing selection.
- Request further information and/or site investigation (including the undertaking of any pull tests) if they deem it necessary.

It is the responsibility of the project managers to ensure the project structural engineer:

- Confirms that any loads imposed on the building structure by building services are accounted for and acceptable within the overall structural design. (the accurate load information provided by NG Bailey may differ from the original allowances and estimates)
- Confirms that the fixings and fixing methods proposed by NG Bailey are acceptable, and provide details of any exclusions or restrictions that may apply (e.g. maximum drill depths, areas or zones that cannot be drilled or used to support services)

8.1.1.2 All fixings and supports shall be installed by suitably skilled operative’s in-line with manufacturer’s recommendations.

8.1.1.3 Where compliance with BS 8539:2012 is required, all fixings into concrete shall be installed in accordance with manufacturer’s instructions by trained operatives working under the supervision of Construction Fixing Association (CFA) certified supervisors.

8.1.2 Brackets

8.1.2.1 All metal channel (Unistrut type) used for support systems shall be manufactured in line with BS 6946.

8.1.2.2 All Parallel Flange Channel (PFC) used for support systems shall be manufactured in line with BS EN 10365.

Threaded rod used for support systems shall be manufactured to BS 3643.

All threaded rod shall have metric threads (e.g. M10, M12, M16 etc)

Where possible threaded drop rods will consist of a single un-joined length.

8.1.2.3 All Brackets Installed by NG Bailey shall utilize components (Unistrut, Threaded Rod, Nuts & Bolts etc.) supplied from NG Bailey approved suppliers.

8.1.2.4 All bracket components (e.g. fixings into building fabric/structure, drop rods, Unistrut or steel tiers) shall be sized to carry the intended load including any required allowances for spare capacity.

8.1.2.5 Where supports, fixings and brackets have been designed and do not take into account the loads imposed on them during the installation (e.g. The additional forces and loads that they may be subjected to when cables are being pulled and man handled into place), temporary supports, brackets, stays and rollers designed to withstand such additional loads and forces must be used.

8.1.2.6 Where brackets support any cables or services which form part of a “Life Safety” system, the bracket shall be designed to withstand a fire condition not less than the fire survival time of the most onerous service being supported by the bracket.

8.1.2.7 All Brackets will be designed and supplied by NG Bailey Offsite Manufacture.

8.1.2.8 Once levelled and secured all protruding bracket drop rods will be cut to a maximum distance of 15mm. deburred and fitted with a push on protective rubber cap

8.1.2.9 Bracket Unistrut (or steelwork) shall be deburred and painted to prevent corrosion. Unistrut brackets will be fitted with protective endcaps.

8.1.2.10 All Bracket tiers are to be levelled, all drop rods are to be installed vertical (by eye, minor tolerances are acceptable).

8.1.3 Containment Systems General

8.1.3.1 Containment and Containment support systems shall be selected to suit the environment in which they are being installed (e.g. appropriate finishes and IP ratings)

8.1.3.2 Where cable containment systems are routed such that they may be exposed to mechanical damage, additional barriers and protection shall be installed (e.g. where cable containment systems are routed vertically through a generally accessible area or unloading/delivery route or zone).

Note: The provision of additional mechanical protection may not necessarily be the responsibility of the electrical installer, where this is the case the installer shall indicate on his drawings where such protection is required.

8.1.4 Penetrations through Fire Rated Walls, Floors, Ceilings or Barriers

Note: This section shall apply where NG Bailey are responsible for undertaking or providing the passive stopping around electrical services. Where fire stopping is the responsibility of the main contractor, or a separately appointed specialist the work will be undertaken in line with their own particular requirements.

8.1.4.1 All holes or penetrations for electrical containment systems, busbar systems or cables which pass through a fire rated wall, floor, ceiling, partition or barrier shall be sealed using an approved and UKAS accredited, certified proprietary fire stopping product or system.

8.1.4.2 The installation of any fire stopping products or systems shall be carried out by a UKAS accredited certified installer.

8.1.4.3 Fire stopping in and around any electrical containment, cable or service penetration shall have a time withstand rating under fire conditions equal to, or greater than the respective fire wall / barrier.

8.1.4.4 The installer (in conjunction with the fire stopping product manufacturer) shall underwrite the finished fire stopping installation for all penetrations.

8.1.5 Penetrations through Acoustic Walls, Floors, Ceilings or Barriers

Note: This section shall apply where NG Bailey are responsible for installing electrical services and systems which pass through any part of the building structure or fabric that has been intentionally designed to limit the transfer of airborne noise.

8.1.5.1 All holes or penetrations for electrical containment systems, busbar systems or cables which are required to pass through acoustic walls, floors, ceilings, partitions or barriers shall fully detailed and agreed with the project acoustic specialist prior to being cut or formed on site.

8.1.5.2 Where the responsibility for sealing and making good any holes or penetrations through acoustic walls lies with NG Bailey, the work shall be undertaken in accordance with the project acoustic specialist's specification. Where NG Bailey are responsible for the design of any acoustic penetrations, they shall employ their own acoustic specialist to undertake such design work and to provide specialist advice.

8.1.5.3 Where the sealing of holes or penetrations is required to prevent the spread/transfer of both fire and noise, the installation of any acoustic/fire stopping products or systems shall be carried out by a UKAS accredited certified installers.

8.1.6 Noise and Vibration Controls

> Note: This section shall apply where it has been determined that the project, or areas of the project, require the electrical services and systems to be acoustically isolated from the building structure to avoid the potential transmission of noise and vibration via the physical structure. In such cases it is expected that a noise and vibration specialist will have been appointed (by others) to undertake the appropriate noise and vibration studies and produce the necessary project requirements and specification(s).

8.1.6.1 Where specified suspended electrical equipment and services shall be fitted with isolating springs and mounts to mitigate the transfer of noise/vibration into the building structure. All anti-vibration measures shall be specified by an acoustic/noise and vibration specialist, and installed in accordance with the product manufacturer's recommendations.

8.1.6.2 Where specified anti-vibration joints and connectors shall be installed in-line of electrical services and containment. The details of such arrangements shall be specified and approved by the project acoustic/noise and vibration specialist, and installed in accordance with the product manufacturer's recommendations.

8.1.6.3 Where specified electrical plant and equipment shall be supported on anti-vibration mounts and where necessary incorporate inertia bases/plinths. The details of such arrangements shall be specified and approved by the project acoustic/noise vibration specialist, and installed in accordance with the product manufacturer's recommendations.

8.1.7 Cable ties and cleats

8.1.7.1 The spacing of all cable ties, supports and cleats must not exceed the maximum distances recommended by the cable manufacturer.

8.1.7.2 To avoid premature collapse in the event of a fire, cable ties, supports and cleats must comply with regulation 521.10.202 of BS 7671, 18th Edition Wiring Regulations.

8.1.7.3 Where three phase and neutral supplies (TP&N) are distributed using single core cables quadrofoil cleats may be used, where three phase supplies (TP) are distributed without a neutral conductor, trefoil cleats shall be used.

8.1.8 Cable Installation

Main and Sub-main cabling shall be installed (pulled) in accordance with manufacturers recommendations and guidance.

Main and Sub-main cables shall be installed in a manner which does not result in additional loads and stresses being imposed on the containment or the containment support systems.

Appropriately sized temporary supports, brackets and cable rollers shall be installed to support the cables during the cable pulling installation.

Cables shall not be left freely hanging over containment systems (i.e. during installation or awaiting termination), they must be independently supported in a manner which will not result in damage to the cables or containment system.

Where practical the installation sequence of Main and Sub-main cables should be from the largest (heaviest) to smallest (lightest) cable. Each cable should be cleated and secured to the containment systems prior to the installation of subsequent cables.

8.2 Cable Trays and Cable Ladders

8.2.1 General

All cable trays and cable ladders shall be manufactured and tested in accordance with the requirements of BS EN 61537:2007.

All cable trays and cable ladders shall be installed and utilised in accordance with the requirements set out in BS 7671, Requirements for Electrical Installations (IET Wiring Regulations).

Where installed indoors, cable trays shall be manufactured from pre-galvanized mild steel unless otherwise specified

Cable trays installed outdoors, and cable ladders shall be manufactured from mild steel and hot dipped galvanised post manufacture, unless otherwise specified.

All cables trays and cable ladders shall be sized and selected to support the intended number (and weight) of cables including allowance for any required spare capacity and cable thermal spacing requirements specified by the designer/engineer.

8.2.2 Gauge & Duty

Generally medium duty cable trays/ladders shall be utilized unless otherwise specified. The load imposed upon a cable tray/ladder shall not exceed the “safe working loads” published by the manufacturer. For cable trays the use of fishplates may be necessary to achieve the maximum safe working loads (refer to manufacturer’s guidance).

Note: Manufacturer’s “safe working loads (SWL)” may be based upon “IEC load test type III” conditions where the overall tray/ladder arrangement and position of joints provides optimum performance. It may be necessary to reduce the SWL if the actual

installation does not mirror these conditions. If in any doubt the manufacturer should be consulted.

8.2.3 Bends, Tees, Reducers & Accessories

All cable tray/ladder bends and accessories shall be appropriately supported. The radius of all bends, angles and tees shall be selected to ensure the minimum bending radius of any supported cables is not exceeded.

Table 8.1 Maximum Cable Sizes for common type cables installed on Ladder

Ladder Bend Radius	4c LV SWA BS 6724 cu	1c LV AWA BS 6742 cu	3c 11kV Cable BS 6622 cu	3c HV Cable BS 6622 Al
300	50mm^2	500mm^2	Not suitable	Not suitable
450	185mm^2	All sizes	Not suitable	Not suitable
600	300mm^2	All sizes	25mm^2	25mm^2
750	All sizes	All sizes	95mm^2	95mm^2
900	All sizes	All sizes	185mm^2	185mm^2

Where the required maximum cable size cannot be accommodated on standard radius bends a bespoke solution will be necessary.

8.2.4 Joints & Fixings

All cable tray and cable ladder joints shall utilize the manufacturer's recommended proprietary fixings.

Cable trays shall utilize fishplates where necessary to achieve the manufacturer's safe working loads for a given cable tray size and gauge. Where "Quick Fix" spring type jointing brackets are utilized a bolted earth continuity link shall be installed. No fixing bolt shanks shall project into the cable carrying side of the tray.

8.2.5 Cuts and Site Fabricated joints and bends. (Cable Tray)

Where cable trays or cable ladders are cut or machined to length all edges shall be deburred. All exposed unprotected steel shall be painted to protect against corrosion.

Site fabricated bends are permitted where non-standard angles and bends are required.

Cable tray site fabricated bends shall utilize fishplates (or overlaps) and all cut edges shall be deburred and painted to protect against corrosion

8.2.6 Fire Stopping and Acoustic Barriers.

Where cable trays pass through the perimeter of a fire compartment, refer to section 8.1.4 of this specification

Where cable trays pass through a structure intended to limit or restrict the transfer of sound, refer to section 8.1.5 of this specification

8.2.7 Electrolytic Corrosion.

In order to avoid corrosion due to electrolytic action, cables with exposed metallic sheaths or coverings manufactured from dissimilar metals to the cable tray/ladder

shall not be installed in contact with the cable tray/ladder unless precautions are taken to avoid the consequences of such contact.

8.2.8 Cable Tray and Ladder Manufacturers

Unless otherwise specified cable trays/ladders shall be manufactured by [list or link to list here]. Cable tray and cable ladder systems, including all associated accessories should be supplied from one manufacturer throughout.

8.3 Cable Basket (steel wire cable tray)

8.3.1 General

All cable basket shall be manufactured and tested in accordance with the requirements of BS EN 61537:2007.

All cable basket shall be installed and utilised in accordance with the requirements set out in BS 7671, Requirements for Electrical Installations.

Where installed indoors, cable basket shall be manufactured from pre-galvanized mild steel, where installed outdoors cable basket finish shall be hot dipped galvanised post manufacture, unless otherwise specified.

All cables baskets shall be sized and selected to support the intended number (and weight) of cables including allowance for any required spare capacity and cable thermal spacing requirements specified by the designer/engineer.

8.3.2 Gauge & Duty

The load imposed upon a cable basket shall not exceed the “safe working loads” published by the manufacturer.

8.3.3 Bends, Tees, Reducers & Accessories

All cable basket bends and accessories shall be appropriately supported. The radius of all bends, angles and tees shall be selected or fabricated to ensure the minimum bending radius of any supported cables is not exceeded.

8.3.4 Joints & Joint Fixings

All cable basket joints shall utilize the manufacturer’s recommended proprietary fixings installed in accordance with the manufacturer’s instructions.

Manufacturers recommended torque settings shall be followed.

8.3.5 Cuts and Site Fabricated joints and bends

Where cable baskets are cut or machined to length all edges shall be deburred. All exposed unprotected steel shall be painted to protect against corrosion.

Fabricated bends shall be constructed utilizing the components and accessories supplied from the manufacturer and fitted in accordance with their instructions.

8.3.6 Fire Stopping and Acoustic Barriers.

Where cable baskets pass through the perimeter of a fire compartment, refer to section 8.1.4 of this specification

Where cable baskets pass through a structure intended to limit or restrict the transfer of sound, refer to section 8.1.5 of this specification

8.3.7 Electrolytic Corrosion.

In order to avoid corrosion due to electrolytic action, cables with exposed metallic sheaths or coverings manufactured from dissimilar metals to the cable basket shall not be installed in contact with the cable basket unless precautions are taken to avoid the consequences of such contact.

8.3.8 Cable Basket Manufacturers

Unless otherwise specified cable baskets and steel wire cable trays shall be manufactured by [list or link to list here]. Cable basket systems, including all associated accessories should be supplied from one manufacturer throughout.

8.4 Cable Trunking

8.4.1 General

All cable trunking shall be manufactured and tested in accordance with the requirements of BS EN 50085.

All cable underfloor duct trunking shall be manufactured and installed in accordance with BS 4678-2.

All cable trunking shall be installed and utilised in accordance with the requirements set out in BS 7671, Requirements for Electrical Installations (IET Wiring Regulations).

All cable trunking shall be manufactured from pre-galvanized mild steel unless otherwise specified.

In the absence of specific employers' requirements, trunking's shall be initially sized with a 25% additional spare capacity for future cables. The additional spare capacity shall be calculated against the number of circuits intended to be installed in the trunking (i.e. a trunking that is filled to 50% of it's maximum capacity has 100% spare capacity because it can additionally accommodate the same number of cables)

To avoid damaging cable insulation, cables shall be laid into, and not drawn through trunking systems. Where the open face of trunking systems is not continuous (e.g. through closed flange or crossover section) the cables shall be carefully fed through avoiding contact and damage to other circuits.

Earth continuity straps across trunking joints are not generally required. Unless the trunking manufacturer specifically states they are necessary they shall not be installed. Site fabricated joints shall incorporate earth links. The entire trunking system shall be appropriately tested to ensure electrical continuity.

8.4.2 IP Rating

Where there is a particular client or project requirement for trunking systems to meet the IP4X, only trunking, and trunking accessories manufactured to meet IP4X shall be installed.

Where steel trunking systems are routed through openly accessible areas or spaces, and where the trunking can be accessed without the need for access equipment, IP4X trunking systems shall be used.

Where the above does not apply, standard IP3X trunking systems installed to a high level of workmanship to meet IPXXD shall be used.

8.4.3 Bends, Tees, Reducers & Accessories

All trunking straight lengths, bends, tees, reducers, flanges, lid and jointing pieces shall be manufactured by the same manufacturer, and be installed in line with the manufacturers recommendations.

Trunking lid fixings shall have a minimum spacing of 600mm. Trunking Lid must be secured using the manufacturers proprietary fixings, self-tapping screws shall not be used.

8.4.4 Horizontally Routed Trunking

Supports spacings for horizontally routed trunking shall comply with the manufacturer's recommendations. Standard trunking (i.e. not lighting trunking) support spacings shall not exceed 3m.

Where trunkings are installed horizontally on brackets or stirrups the opening shall face upwards.

Where trunking is routed horizontally, and fixed directly to a vertical wall or structure the opening shall face away from the wall or structure. When installed in this manner cable retainers shall be fitted at 1m intervals, and at each change of direction.

Where it is necessary to install steel lighting trunking with the open face downwards, cable retainers shall be fitted at 1m intervals, and at each change in direction.

8.4.5 Vertical Routed Trunking

Pin racks with a maximum spacing of 3m shall be used on vertically routed trunkings to supports the weight of the cables. Where pin racks are used trunking sizes shall be increased to maintain the desired space factor and spare capacities.

8.4.6 Cuts and Site Fabricated joints and bends.

Where non-standard bends and angles are required, site fabricated joints are permitted. All site fabricated joints shall be neatly formed with all cut edges deburred and painted to protect against corrosion.

8.4.7 Fire Stopping and Acoustic Barriers.

Where cable trunkings pass through the perimeter of a fire compartment, refer to section 8.1.4 of this specification

Where cable trunkings pass through a structure intended to limit or restrict the transfer of sound, refer to section 8.1.5 of this specification

8.4.8 Electrolytic Corrosion.

In order to avoid corrosion due to electrolytic action, cables with exposed metallic sheaths or coverings manufactured from dissimilar metals to the cable trunking shall

not be installed in contact with the cable trunking unless precautions are taken to avoid the consequences of such contact.

8.4.9 Cable Trunking Manufacturers

Unless otherwise specified cable trunkings shall be manufactured by [list or link to list here]. Cable trunking systems, including all associated accessories should be supplied from one manufacturer throughout

8.5 PVC Trunking / Dado Trunking

8.5.1 General

Non-metallic cable trunking shall comply with the relevant parts of:

- BS 4678-4 (Cable trunking, manufactured from insulating material)
- BS EN 50085 (series) (Cable trunking and cable ducting systems)

PVC trunking shall be supported by steel brackets/hangers that fully wrap around the body of the trunking (open type G clamps are not permitted).

Installation and bracket/support spacing shall be in accordance with manufacturers recommendations. Bracket/support spacing shall not exceed 1.5m.

All trunking bends, tees and accessories shall be supplied by the same manufacturer

PVC trunking shall be manufactured from flame retardant, non-flame propagating material, and should be 100% recyclable.

8.5.2 PVC Dado Trunking

PVC dado trunking shall utilise proprietary metal cable retainers that are independently fixed directly into the wall/building fabric. Cable retainers shall be spaced a maximum of 1m apart.

8.6 Conduit

8.6.1 General

All metallic, non-metallic and composite conduit systems and accessories shall be manufactured and tested in accordance with the relevant parts of:

- BS EN 61386-1 (Conduit systems for cable management. General requirements)
- BS EN 61386-25 (Conduit systems for cable management. Particular requirements. Conduit fixing devices)

Where conduits are to be buried underground, they shall manufactured and tested in accordance with:

- BS EN 61386-24 (Conduit systems for cable management. Conduit system buried underground)

All conduit systems shall be installed and utilised in accordance with BS 7671, Requirements for Electrical Installations (IET Wiring Regulations).

IET Guidance Note 1 Appendix A shall be used to determine the capacities and recommended number of cables than can be drawn into conduits.

Conduit systems shall utilise components and accessories supplied form one manufacturer only.

8.6.2 Steel Conduit

All steel conduit shall be Heavy Gauge Welded and screwed (i.e. the conduit itself shall be threaded).

All steel conduit shall be Hot Dipped Galvanised (Inside and Out)

All Conduit boxes shall be Malleable iron (Galvanised)

Factory made bends, Inspection bends, Inspection tees, and Inspection couplers shall not be utilised unless indicated on the installation drawings.

Galvanised Spacer-bar or Distance saddles shall be utilised to suit the particular installation.

“Running Couplings” shall be avoided where possible, where they are necessary all exposed conduit threads shall be painted to avoid corrosion using “Galvafroid” Zinc rich paint.

Conduit shall be installed in-line with manufacturer’s instructions and recommendations.

Where possible, all cables/circuits should be drawn into conduit run in a single pull (to avoid cutting through the insulation on the cables).

8.6.3 PVC Conduit

PVC conduit shall be manufactured from high impact PVCu which is self-extinguishing and non-flame propagating in accordance with BS 4678-4

PVC Conduit shall be supported using galvanised steel Spacer-bar or Distance saddles to suit the particular installation.

The spacing between saddles for PVCu conduit shall be in line with manufacturers recommendations and shall not exceed 1.5M on horizontal runs and 1.75M on vertical runs.

Proprietary waterproof adhesives shall be used all joints as recommended by the conduit manufacturer.

8.6.4 Flexible Conduit

Flexible conduit shall be manufactured and tested in accordance with:

- BS EN 61386-23 (Conduit systems for cable management. Particular requirements. Flexible conduit systems)

Unless part of proprietary modular wiring system, the lengths of flexible conduit shall be kept to a minimum (i.e. less than 1m where used as the final connection to a vibrating item of equipment, less than 3m when connecting to a movable floor box)

Flexible conduit fittings and connectors shall be supplied by the same manufacturer as the flexible conduit.

Steel flexible conduit shall not be used as CPC. A separate, suitably sized green/yellow insulated conductor shall be used for each individual circuit, or as detailed by the electrical design engineer.

Flexible conduits shall not be relied upon to provide mechanical protection for cables installed within partitions or embedded within the building fabric.

8.7 External Underground Cable Ducts and Draw Pits

8.7.1 General

The excavation, construction and provision of trenches, drawpits, manholes and ducting systems for underground electrical services are civil engineering works and should be undertaken by the main contractor (or civils contractor) on behalf of the building services sub-contractor.

The building services consulting engineer or design sub-contractor shall liaise with the main contractor to define the project specific requirements for all underground electrical services. This shall include, but not be limited to:

- The production of drawings and schedules indicating point to point routing of all underground cables and services
- The production of specifications and schedules detailing the minimum/maximum buried depths for all electrical services.
- The production of drawings, details and specifications indicating the minimum bending radii of cables and required sizes of underground ducting.
- Details of any external lighting column foundations/bases (in conjunction with the column supplier/manufacturer)
- Details of any external plinths including any required earthing arrangements (e.g. for ‘lucy’ type external distribution/feeder pillars)
- Specification detailing any specific requirements for trench backfill (soil types / fill medium) including any tiling and/or PVC taping requirements.
- The production of ‘as installed’ drawings and information, including highlighting any specific CDM residual risk (e.g. concerning the dangers related to buried High Voltage services)
- Defining any requirements for the drainage or the pumping of standing or rainwater water from draw pits and cable ducts.
- Defining any requirements to control pests or vermin accessing cable chambers or ducts.

Where buried electric cable ducts are routed under public roads, highways and pedestrian walkways or where they are intended for cables serving non-privately owned power distribution systems they shall conform to the relevant requirements of:

- The National Joint Utilities Group (NJUG) Information on street works UK publications. Guideline volumes 1 to 6
- ENA Technical Specification 12-24 (Technical specification for Plastic Ducts for Buried Electric Cables)
- BS 65 (Specification for vitrified clay pipes, fittings and ducts, also flexible mechanical joints for use solely with surface water pipes and fittings.)
- BS EN 124 [series] – (Gully tops and manhole tops for vehicular and pedestrian areas.)

Where the underground services are part of a Network Rail contract the relevant Network Rail policies, standards and requirements shall be observed, these include, but are not limited to:

- NR/L1/AMG/1010 (Policy on Working Safely in the Vicinity of Buried Services)
- NR/L2/AMG/1020 (Buried Services Data Provision)
- NR/L2/AMG/1030 (Working Safely in the Vicinity of Buried Services)
- NR/L2/AMG/1040 (Buried Services Data Feedback)
- NR/GN/TEL/30138 (Buried Cable Route and Cable Route Through Station Platform)
- NR/L2/CIV/140 [Sections 190 & 191] (Model Clauses for Civil Engineering Works, External Service Ducts and Cable Troughing)

All buried cable ducts and draw pits shall be provided (by the installer of the duct) with suitable draw wires/ropes, which shall be suitably tied off at both ends of the duct.

9 Earthing and Bonding

9.1 General

All earthing and bonding systems shall conform the requirements of BS 7430 (Code of Practice for Protective Earthing of Electrical Installations Installations) and BS 7671 (Requirements for Electrical Installations)

The star point (neutral) of every distribution transformer shall be securely connected to the general mass of earth. The means of connection to the general mass of earth shall be via the Earth Electrode.

All Earthing and Bonding terminations shall be clearly labelled with the words “SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE”

Earthing clamps for bonding pipes and lead sheathed cables shall comply with BS 951.

9.2 Definitions

For the purposes of this Standard Specification the definitions given in BS IEC 60050 apply, together with the following.

9.2.1 Bonding Conductor

Protective conductor providing equipotential bonding

9.2.2 Earth

Conductive mass of Earth, whose electric potential at any point is conventionally taken as zero

9.2.3 Earth Electrode

Conductor or group of conductors in intimate contact with, and providing an electrical connection to, Earth

9.2.4 Earth Electrode Resistance

Resistance of an Electrode to Earth

9.2.5 **Earth Fault Current**

A current resulting from a fault of negligible impedance between a line conductor and an exposed conductive part or a protective conductor.

9.2.6 **Earth Fault Loop Impedance**

Impedance of the earth fault current loop, starting and ending at the point of earth fault. This impedance is denoted by the symbol Z_s

The earth fault loop comprises the following, starting at the point of fault:

- the circuit protective conductor; and
- the consumer's earthing terminal and earthing conductor; and
- for TN systems, the metallic return path; or
- for TT and IT systems, the earth return path; and
- the path through the earthed neutral point of the transformer and
- the transformer winding; and
- the line conductor from the transformer to the point of fault.

9.2.7 **Earth Grid**

Earth electrode in the form of two overlapping groups of buried, parallel, horizontal electrodes, usually laid approximately at right angles to each other, with the electrodes bonded at each intersection.

9.2.8 **Earthing Conductor**

A protective conductor connecting the main earthing terminal of an installation to an earth electrode or to other means of earthing

9.2.9 **Earthing System**

Arrangement of connections and devices necessary to earth equipment or a system separately or jointly.

9.2.10 **Electrically Independent Earth Electrodes**

Earth electrodes located at such a distance from one another that the maximum current likely to flow through one of them does not significantly affect the potential of the other(s)

9.2.11 **Equipotential Bonding**

Electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential

9.2.12 **Exposed-conductive-part**

Conductive part of equipment which can be touched and which is not normally live, part but which can become live under fault conditions

9.2.13 **Extraneous-conductive-part**

Conductive part liable to introduce a potential, generally Earth potential, and not forming part of the electrical installation

9.2.14 **Main Earthing Terminal**

The terminal or bar provided for the connection of protective conductors, including protective bonding conductors, and conductors for functional earthing, if any, to the means of earthing

9.2.15 **Protective Conductor (PE)**

Conductor used for some measures of protection against electric shock and intended for connecting together any of the following parts:

- exposed-conductive-parts;
- extraneous-conductive-parts;
- the main earthing terminal;
- earth electrode(s);
- the earthed point of the source, or an artificial neutral

9.2.16 **Simultaneously Accessible Parts**

Conductors or conductive parts which can be touched simultaneously by a person or, in locations specifically intended for them, by livestock.

Note: Simultaneously accessible parts may be: live parts; exposed-conductive-parts; extraneous-conductive-parts; protective conductors; or earth electrodes.

9.3 Materials and Products

9.3.1 Conductors

Use only copper conductors, cable or tape as appropriate to the particular installation

Cables to be insulated and manufactured to BS 6004 (PVC) or BS 7211 (LSF), insulation to be coloured green/yellow.

Tapes to be bare copper (with regular green/yellow markings) or insulated with PVC or LSF and manufactured to BS EN 13601, C101 or C102. Insulation shall be coloured green/yellow.

Other types of circuit protective conductors include:

- metallic screwed conduit (not flexible);
- metallic trunking with tinned copper links;
- the armouring of armoured cables (including mining / quarries specification cables with copper strands in the armouring);
- integral conductor of multi-core cables;
- the copper sheath of MICC cable.

Bare protective conductors in twin and three-core cables included in BS 6004, Table 5, are acceptable (subject to being adequately sized).

9.3.2 Earth Electrodes

9.3.2.1 Earth Rods

Unless otherwise specified, earth rods to be 15 mm diameter extensive molecularly bonded clad high tensile steel rods connected together. They should be connected together using couplings manufactured from silicon bronze alloy to BS EN 12163, Grade CS101, counter bored to completely enclose rod threads.

9.3.2.2 Earth Mats/Plates

Earth mats / plates shall be 600 x 600 mm minimum of solid or lattice copper not less than 3 mm thick.

9.3.2.3 Pipe Electrodes

Pipe electrodes shall be flanged pipe to BS EN 545, 150 mm bore and 3.0 m long. Pipe to be shot blasted to remove all scale and rust.

9.3.2.4 Tape Electrodes

Tape electrodes shall utilise copper tape to BS EN 13601 C101 or C102 of minimum section 25 x 3 mm. The tape shall be arranged in a zig-zag pattern in a pre-prepared trench, with a minimum cover of 600 mm of well-draining back fill.

9.3.2.5 Building Structural Elements

BS 7671 permits the use of suitable structural or other underground metalwork, or the metal reinforcement of concrete embedded in the ground. However, BS 7430 implies that when a significant continuous d.c. leakage current is present this method should be avoided. Generally, this should not be problematic for typical electrical building services installations. If specialist systems (extensive d.c. power systems for example) are incorporated, seek advice from the designer.

9.3.3 Earth Bars

Earth bars shall be manufactured from hard drawn, high conductivity copper bar. Unless specified elsewhere the minimum size will be 50 mm x 6 mm.

9.4 Workmanship

9.4.1 Earth Electrode (Main Earth Nest)

Generally, use copper clad steel ‘Earth Rods’ for earth electrodes made up of the appropriate number of driven earth rods. Alternatives are ‘Earth Mats/Plates’, ‘Pipe Electrodes’, buried copper ‘Tape Electrodes’ and ‘Building Structural Elements’ (structural steelwork and foundations of buildings).

Earth rods should be driven in undisturbed ground using the proprietary driving head and coupling. Rods should not exceed 4m in length since no appreciable benefit is

obtained below this depth. The number of earth rods required to achieve the desired resistance shall be estimated by calculation and confirmed by testing.

The spacing between any two electrodes shall not be less than the depth of the longer electrode.

Where impenetrable strata are encountered at shallow depth, drive at 30° to horizontal.

Where earth rods are to be installed through the base slab of a building, electrode seals shall be provided. Either, the rods shall be driven and the seals fitted before the concrete is poured, or the seals be handed to the main contractor for him to incorporate in the slab to allow the rods to be driven later.

Locate electrodes not less than 2 m from building and away from telecommunications and data cables, and metallic fences.

Where rods for 'clean' earths are installed, ensure distance from any other system rods is six times depth of 'clean' rods.

Interconnect rods with bare copper cable or copper tape, buried minimum 500 mm below finished ground level, rising vertically at each electrode.

Connect groups of electrodes to main earth conductor via bolted link in purpose-made inspection pit as detailed in BS 7430 for test purposes.

The inspection pit shall have a removable top cover which shall be flush with finished ground level. The earth electrode connection shall be just below the lid of the inspection pit with adequate access for testing.

Connections to earth rods shall be by bronze, gun metal or copper clamps with phosphor-bronze bolts; edges of clamps shall be 'rounded'.

Connections of main earth conductor to main earthing bar shall be phosphor-bronze bolts and nuts. Cables shall be fitted with compression lugs; earth tapes shall be drilled or punched as appropriate.

9.4.2 Main Earth Bars

Main earth bars shall be manufactured from 50 x 6 mm minimum, hard drawn, high conductivity copper bar. The earth bar shall be mounted on stand-off insulators. A laminated label shall be fitted to the wall adjacent to the earth bar with 10 mm high RED letters on WHITE background reading 'MAIN EARTH BAR'. All main earth bars shall be fitted with a removable test link, secured to the main earth bar by 12 mm high tensile brass bolts, nuts and locking devices.

All earthing/bonding cables and tapes connected to the main earth bar shall be fitted with a permanent label durably marked indicating its purpose/destination/source.

9.4.3 Main Earthing Conductors

Main earthing conductors are a vital part of the earthing system and must be sized and installed to ensure that in the event of a fault the earth fault current will not cause damage to the conductors.

The size of an earthing conductor is arrived at in basically the same way as for a cpc except that Table 54.1 of BS 7671 must be applied to any buried earthing conductor. For a TN-C-S (PME) supply, the Distribution Network Operator (DNO) will size the earthing conductor in relation to the neutral/earth of the incoming cable.

Where the supply is at HV and the transformer sub-station is to be installed by the Company, the main LV earthing conductors shall be sized in accordance with the Table 1 below:

Table 9.1

Transformer Rating (kVA)	Main Earthing Conductor Size (based on Cu PVC 6491X or LSF 6491B) [mm²]
315	70
500	120
630	120
800	150
1000	240
1250	240
1500	300 or 2 x 150
1600	300 or 2 x 150
2000	2 x 185
2500	2 x 240
3000	2 x 240
3500	2 x 300
4000	2 x 300
4500	3 x 240

Table 9.2

Cross Sectional Area of Incoming Phase Conductor (meter tail) 'S'	Minimum Size of Main Earthing Conductor (copper)
35 mm² or less	16 mm²
50 mm²	25 mm²
70 mm²	35 mm²
95 mm²	50 mm²
120 mm²	70 mm²
150 mm²	95 mm²
above 150 mm²	2x95mm²

9.4.4 Main Protective Bonding Conductors

Except where PME conditions apply, a main protective bonding conductor shall be of a cross-sectional area (CSA) not less than half the CSA of the earthing conductor for the installation with a minimum size of 6 mm². The CSA need not exceed 25 mm² (copper).

Where PME conditions apply, the CSA of the main equipotential bonding conductor is based on the CSA of the neutral conductor of the supply, as detailed in Table 54.8 of BS 7671 (replicated in table 3 below):

Table 9.3

Copper equivalent CSA of supply neutral conductor	Minimum copper CSA of the main equipotential bonding conductor
35 mm² or less	10 mm²
over 35 mm² up to 50 mm²	16 mm²
over 50 mm² up to 95 mm²	25 mm²
over 95 mm² up to 150 mm²	35 mm²
over 150 mm²	50 mm²

Distribution Network Operators (DNO's) however, may have more onerous requirements.

Extraneous-conductive-parts should preferably be bonded using individual main protective bonding conductors. Alternatively, two or more such parts may share a main protective bonding conductor, but where this arrangement is employed the conductor must be continuous, i.e. disconnection of the conductor from one extraneous-conductive-part must not interfere with or endanger the security of the bonding of other part(s). In general, unless excessive cable lengths are involved, Company installations will have individual main protective bonding conductors.

Where the installation is within a building which has exposed metallic structural parts, these must be bonded as if they are extraneous-conductive-parts, i.e. the structural metalwork is in contact with the ground or other unbonded metalwork. Where the structure concerned is assembled from components, which are welded, bolted or riveted together, then one main bonding connection will suffice.

A permanent label is required to be fixed at or near the point of connection of every main protective bonding conductor to an extraneous-conductive-part.

9.5 General Installation Earthing

9.5.1 Protective Conductors

Unless the circuit protective conductor (CPC) has been sized by the design engineers and specific sizes given, then the CPC shall be sized in relation to the phase conductor in accordance with Table 54.7 of BS 7671.

Table 9.4 - For copper phase conductors and copper CPC's it is as follows:

CSA of Phase Conductor (S) mm²	CSA of CPC
S ≤ 16	S
< S ≤ 35	16
S > 35	S/2

If the CPC is not an integral part of the cable, or is not formed by conduit or trunking, or is not contained in conduit or trunking, then the CSA shall not be less than 2.5 mm² if mechanical protection is provided, or 4.0 mm², if no mechanical protection is provided.

Where a CPC is common to several circuits, its CSA shall be selected to relate to the largest phase conductor of the circuits.

A protective conductor (CPC) may consist of one or more of the following:

- a single core copper cable;
- a copper conductor in a multi-core cable;
- an insulated copper conductor in a containment system with insulated live conductors;
- a fixed bare or insulated copper conductor;
- the metal sheath or armouring of a cable;
- a metal conduit or trunking or other electrically continuous support system for conductors;
- An extraneous-conductive-part provided it has been considered for such use and if necessary adapted – see BS 7671 Clause 543.2.6. Note: Neither a gas pipe nor an oil pipe can be considered for use in this context.

Where conduit or the protective sheath or armour of a cable is used as a CPC, the earthing terminal of each accessory shall be connected by a separate CPC to the earthing terminal in the associated box or other enclosure.

Where the sheath of a cable incorporating a bare CPC is removed adjacent to joints and terminations, the protective conductor shall be protected by insulated sleeving complying with BS EN 60684.

Every joint in metallic conduit shall be mechanically and electrically continuous by screwing or substantial mechanical clamps. Plain slip or pin-grip sockets shall not be used for earthing continuity.

Flexible or pliable conduit shall not be used as a CPC.

The armouring of PVC or LSF sheathed cables shall terminate in a suitable compression gland fitted with a purpose-made earth tag. The earth tag shall be manufactured from high conductivity material compatible with the cable gland.

A suitable protective conductor sized in accordance with BS 7671 Table 54.7 shall connect the earth tag to the main earth bar/terminal of the apparatus or main switchboard as appropriate.

Where several armoured cables are terminated into a common gland plate, one of the following methods shall be used:

i. Drill the gland plate, clean and remove all burrs, and bolt the earth tags directly to the gland plate. A separate CPC sized in relation to the largest phase conductor shall then be used to earth the gland plate to the main earthing terminal.
ii. As above, but with an 'earth tail' connecting all earth tags together, with a CPC from one earth tag to the gland plate and from the gland plate to the main earthing terminal. The 'earth tails' can be sized to suit the phase conductors of the individual cables as long as the minimum CPC size is maintained in the links for each cable back to the glandplate connection). The connection to the gland plate and the main earthing terminal to be sized in relation to the largest phase conductor terminated.
iii. Individual CPC's, sized to suit the individual phase conductors, shall be run from the earth tag to the main earthing terminal.

All glands to be fitted with shrouds to match the material and colour finish of the cable sheath. For outdoor terminations the armouring under the shroud shall be suitably protected to prevent corrosion.

9.5.2 Supplementary Equipotential Bonding Conductors

Supplementary equipotential bonding is required by BS 7671 to be provided in the following situations:

i. where the conditions for automatic disconnection cannot be met; i.e. Zs recorded exceeds max Zs for protective device;
ii. for some installations of increased shock risk – see BS 7671 Part 7.

Supplementary bonding can be provided by a supplementary conductor, a conductive part of permanent and reliable nature or a combination of both.

If not provided with mechanical protection, all supplementary bonding conductors must be at least 4 mm².

For a fixed appliance connected to an adjacent connection unit, the CPC within the flexible cord providing the connection may be used as the supplementary conductor.

It is not a requirement of BS 7671 to run a supplementary bonding conductor back to the main earthing terminal of the installation. Locally bonded parts will be connected to the main earthing terminal via one or more of the CPC's and/or extraneous-conductive-parts.

A supplementary bonding conductor between exposed-conductive-parts shall be not less than the smaller of the CPCs connected to the exposed-conductive parts.

A supplementary bonding conductor between an exposed-conductive-part and an extraneous-conductive-part shall be not less than half the CSA of the CPC connected to the exposed-conductive-part.

A supplementary bonding conductor between two extraneous-conductive-parts shall be a minimum of 2.5 mm². However, if one of the extraneous-conductive-parts is also connected to an exposed-conductive-part, then the supplementary bonding conductor shall be not less than half the CSA of the CPC connected to the exposed-conductive-part.

In all three situations quoted it is assumed the supplementary bonding conductor is sheathed or otherwise provided with mechanical protection. Should this not be the case, then a minimum of 4 mm² applies.

9.5.3 Suspended Ceilings

Parts 1 and 3 of the British Standard for suspended ceilings, BS EN 13964, contain a number of design and maintenance requirements relating to the earthing and bonding of conductive parts of ceiling suspension systems with which, in practice, it would be difficult to comply. Fortunately for the electrical designer and contractor, those electrical safety requirements are applicable only if the conductive parts of the ceiling are intended to be used to conduct earth fault current, or to act as an equipotential bonding conductor.

In practice, unless there are very exceptional circumstances (which would need to be taken into account by the electrical designer), the conductive parts of a ceiling suspension system will be neither exposed-conductive-parts, nor extraneous-conductive-parts. Consequently, in normal circumstances, such ceiling suspension systems need neither to be earthed nor equipotentially bonded.

Electrical equipment, such as luminaires, lighting track, overhead busbars, air conditioning units and the like incorporated in a suspended ceiling will normally be of either Class I or Class II construction. The exposed-conductive parts of Class I equipment are required to be connected to the main earthing terminal of the installation by a protective conductor designed to conduct any earth fault current. Class II equipment is designed such that any insulation fault in the equipment cannot result in fault current flowing into any conductive parts with which it may be in contact. The conductive parts of a suspended ceiling incorporating Class I and/or Class II equipment are therefore not expected to conduct earth fault current, and so such parts need not be intentionally earthed. (Some conductive parts of a suspended ceiling may be earthed, however, by virtue of fortuitous contact with the exposed-conductive-parts of Class 1 equipment.)

Unless there are exceptional circumstances, the conductive parts of a suspended ceiling will not introduce a potential that does not already exist in the space in which the ceiling is installed. In normal circumstances, therefore, there is no need to arrange for the conductive parts of the ceiling to be equipo tentially bonded.

9.5.4 Raised Floors

The supports and steelwork that support raised access floors are neither exposed conductive parts, nor extraneous-conductive-parts therefore under normal conditions do not require to be equipotentially bonded.

There may be instances when bonding the steelwork of raised access floors is required, for example, to reduce the effects of EMC, or where the designer deems

there is a particular risk. In such instances the designers requirements shall be followed.

9.5.5 Special Locations

BS 7671 recognises that some special installations and locations require precautions to be taken in addition to the general requirements set out in Parts 1 to 6 (inclusive).

Part 7 is divided into several sections. Not all sections fall into the category of installations normally covered by the Company.

This specification addresses the additional requirements and major differences for the earthing of these special installations and locations.

9.5.6 Locations Containing a Bath Tub or Shower Basin

The particular requirements of this section apply to bath tubs, shower basins and their surroundings, where risk of electric shock is increased by a reduction in body resistance and contact of the body with earth potential.

Except for SELV (BS 7671 Chapter 41, Section 414), for a circuit supplying equipment in a room containing a fixed bath or shower, where the equipment is simultaneously accessible with exposed-conductive-parts of other equipment or with extraneous-conductive-parts, the characteristics of the protective devices and earthing arrangements shall be such that, in the event of a fault, disconnection occurs within 0.4 seconds.

In small bathrooms this can apply to the lighting circuit as well as electric showers etc.

Also supplementary bonding (see previous section) shall be provided between accessible exposed-conductive-parts of equipment, between exposed-conductive-parts and simultaneously accessible extraneous-conductive-parts, and between simultaneously accessible extraneous-conductive-parts.

Surface wiring systems shall not employ metallic conduit, or metallic trunking, or an exposed metallic cable sheath, or an exposed earthing or bonding conductor.

Electric heating embedded in a bathroom floor shall be covered by an earthed metallic grid or have an earthed metallic sheath. This grid or sheath shall be connected to the local supplementary equipotential bonding.

9.5.7 Swimming Pools

The particular requirements of this section apply to basins of swimming and paddling pools and their surrounding zones where the risk of electric shock is increased by a reduction in body resistance and contact of the body with earth potential.

There are special requirements for swimming pools for medical use which are not addressed in this specification.

Swimming pools and their surroundings are divided into Zones 0, 1 and 2. Generally the zones are:

- **Zone 0** is the interior of the basin;
- **Zone 1** is limited by a vertical plane 2 m from the rim of the basin and by the floor or surface expected to be accessible to persons and the horizontal plane 2.5 m above the surface. There are special requirements for above-ground pools and pools with diving boards etc. – see BS 7671 Section 702 for more precise details;
- **Zone 2** is generally the same height as Zone 1 and extending 1.5 m beyond it.

Local supplementary equipotential bonding shall be provided connecting all extraneous-conductive-parts in Zones 0, 1 and 2 together, with the protective conductors of all exposed-conductive-parts situated in these zones. Where there is a metal grid in a solid floor it shall be connected to the local supplementary bonding.

In Zones 1 and 2 a surface wiring system must not employ metallic conduit, or metallic trunking, or an exposed metallic cable sheath, or an exposed earthing or bonding conductor.

Zones 1 and 2 shall contain only wiring necessary to supply equipment in those zones. Accessible metal junction boxes shall not be installed in Zones 1 and 2.

An electric heating unit embedded in the floor in Zone 1 or 2 shall incorporate a metallic sheath connected to the local supplementary equipotential bonding or shall be covered by an earthed metallic grid connected to the equipotential bonding specified above.

9.5.8 Construction Sites

The particular requirements of this section shall apply to installations provided for the purpose of electricity supply during the execution of the following works:

- new building construction;
- repair, alteration, extension or demolition of buildings;
- engineering construction;
- earthworks.

The requirements **do not apply** to installations in construction site offices, cloakrooms, canteens, dormitories, toilets etc. where the general requirements of BS 7671 apply.

Construction site **fixed** installations are limited to the assembly of the main switchgear and principal protective devices. An installation on the load side of these items is considered a **movable** installation.

Generally, where a TN system is installed and protection by Automatic Disconnection of Supply (ADS) is used, the maximum permissible disconnection times are as detailed in BS7671 Chapter 41, Section 411, with additional protection provided by an RCD having the characteristics specified in Regulation 415.1.1.

A disconnection time of 0.4 seconds applies to the **fixed** installation (TN system) and 5 seconds to any **reduced low voltage** system on the site.

Note that the maximum allowable Zs figures for the two systems are vastly different.

For 400 / 230 V systems on the **fixed** installation the figures in BS 7671 Regulation 411.4.7 apply. For **reduced low voltage** (63.5V three phase and 55V single phase), the figures in Table 41.6 apply.

9.5.9 Equipment with High Earth Leakage Currents

BS 7671, Chapter 54, Regulations 543.7.1 through to 543.7.2.201 provide particular requirements for every installation and / or circuit having a high earth leakage current (usually exceeding 3.5 mA), including information technology equipment to BS EN 62368-1:2014 and industrial control equipment where values of earth leakage current in normal service, permitted by British Standards, necessitate special precautions being taken in the installation of the equipment.

The principle of the group of regulations is to provide high integrity or duplicate CPCs to equipment which has a standing earth leakage.

It is recommended that equipment with an earth leakage exceeding 10 mA be permanently connected to the fixed wiring. The final connection can be via a flexible cable. If the final connection has to be via a plug and socket, then duplicate CPCs are required.

The most common installation requirement is that of 13 A socket outlets for IT equipment. It is reasonable to expect that in a modern office environment the leakage current on a typical final circuit may exceed 10 mA. The circuit must be provided with a high integrity protective connection complying with the requirements of Regulation 543.7.1.201.

Consider first a ring main. Any socket outlets used on the ring must have duplicate earth connections and the incoming and outgoing CPCs must be terminated separately in these connections.

At the distribution board the two CPCs must be terminated in separate connections (labelled accordingly).

This method ensures that, should any one CPC connection come adrift, there will be an alternative earth connection.

There can be no spurs from the ring and the minimum size of CPC is 1.5 mm².

Regulations 543.7.1.202 and 543.7.1.203 provide alternative methods of providing high integrity protective connections to an item of stationary equipment having an earth leakage current exceeding 10 mA in normal service. Whilst not precluding other methods, Company installations will conform to one of the following:

i) a single protective conductor with a csa of not less than 10 mm²;
ii) separate duplicated protective conductors having independent connections to the equipment, each having a csa of not less than 4 mm²;
iii) duplicate protective conductors incorporated in a multi-core cable together with the live conductors of the circuit, provided that the total csa of all conductors of the cable is not less than 10 mm². One of the protective conductors may be formed by the metallic armour of the cable. An example

of this would be a 3-core 4 mm² SWA cable with the third core and armours forming the duplicate cpcs;

iv) duplicate protective conductors formed by metal conduit or trunking and a cpc not less than 2.5 mm² installed in the same enclosure and connected in parallel with it.

Any of the arrangements listed in (i) to (iv) above can also be used to supply a final circuit.

10 Lightning Protection

10.1 General

Lighting Protection systems shall be designed and installed accordance with the relevant parts of the following standards

- BS 7671 (IET Wiring Regulations)
- BS EN 62305-1 Protection against lightning. General principles)
- BS EN 62305-1 Protection against lightning. Risk management)
- BS EN 62305-1 Protection against lightning. Physical damage to structures and life hazard)
- BS EN 62305-1 Protection against lightning. Electrical and electronic systems within structures)

10.2 System Components

Lightning system components shall be manufactured in accordance with the relevant parts of the following standards:

- BS EN IEC 62561-1 (Lightning protection system components (LPSC). Requirements for connection components)
- BS EN IEC 62561-2 (Lightning protection system components (LPSC). Part 2: Requirements for conductors and earth electrodes)
- BS EN 62561-3 (Lightning protection system components (LPSC). Requirements for isolating spark gaps (ISG))
- BS EN 62561-4 (Lightning protection system components (LPSC). Requirements for conductor fasteners)
- BS EN 62561-5 (Lightning protection system components (LPSC). Requirements for earth electrode inspection housings and earth electrode seals)
- BS EN IEC 62561-6 (Lightning protection system components (LPSC). Requirements for lightning strike counters (LSC))
- BS EN IEC 62561-7 (Lightning protection system components (LPSC). Requirements for earthing enhancing compounds)
- IEC 62561-8 (Lightning protection system components (LPSC). Requirements for components for isolated LPS)
- BS 951 (Earthing and Bonding – Specification for clamps)

All components and fittings of the lighting protection system that form part of the conductor network (excluding building structural steelwork) shall be supplied form the same manufacturer

All building and building structural elements (and connections thereto) that are utilised as part of the lightning protection system must conform to the recommendations set out in BS EN 62305, as well as their appropriate construction and structural specifications.

Lightning conductor copper/aluminum flat tape shall have minimum 25mm x 3mm dimensions.

10.3 Transient Protection Devices

Transient Protection Devices shall be manufactured in accordance with the relevant parts of:

- BS EN 61643 [series] (Components for low-voltage surge protective devices)

10.4 Workmanship

lightning protection system components shall be installed in accordance with manufacturer's instructions and guidance.

Lightning protection system conductors shall be installed in as direct a line as possible avoiding sharp bends and changes of direction. All non-buried conductors shall be securely restrained using the manufacturers proprietary fixings.

11 Lighting and Emergency Lighting Luminaires

11.1 Luminaires

11.1.1 General

All luminaires shall comply with the relevant parts and sections of BS EN 60598 suite of standards.

All luminaire/lamp combinations shall have photometric data available in accordance with:

- BS EN 13032-1 (lamps and luminaires, file format)
- BS EN 13032-2 (indoor and outdoor luminaires)
- BS EN 13032-3 (indoor and outdoor, emergency lighting)
- BS EN 13032-4 (LED lamps and luminaires)

Luminaire ingress protection (IP) shall be classified in accordance with BS EN 60529.

Luminaire impact resistance (IK) shall be classified in accordance with BS EN 62262.

All fully assembled luminaires shall meet the requirements of BS EN 61547 for EMC immunity.

All luminaires shall be supplied complete with lamps in accordance with the project luminaire schedule.

All fluorescent and discharge luminaires shall be fitted with a BS 1362 fuse and fuse holder in the incoming circuit. The incoming circuit terminal block shall be capable of accommodating 3 No. 2.5mm^2 stranded conductors (e.g. 6491B type cable)

Luminaires shall be provided with glass (or other suitable material) covers to protect and filter ultra-violet emissions.

Luminaires that utilise lamps that may explode or shatter towards the end of life shall be fitted with suitable protective covers (e.g. a protective glass cover).

Luminaires must be accessible for maintenance purposes. Where a luminaire is mounted at a height, or in a position where it is not readily accessible (i.e. from the general access equipment available to maintenance engineers) then one of the following shall be considered:

- A proprietary powered luminaire raising and lowering winch shall be fitted.
- The luminaire bracket(s) shall be designed so that they can be safely swung or moved into a suitable position to carry out maintenance.
- A permanent access walkway or gantry shall be provided as part of the main building structure for the purpose of accessing and maintaining luminaires. (an access gantry/walkway may be provided as part of the main contractors work)
- Suitable, safe access shall be provided from the floor or level above the luminaires (such access may require suitably positioned access holes and windows in the primary building structure)
- The lighting scheme shall be re-designed utilising mirrored reflector luminaires which allow safe access to the maintainable parts of the luminaire from low level
- Specialist access plant and equipment shall be provided for use by the client/customers maintenance engineers (such access equipment may be provided by the main contractor for accessing high level areas generally)

Where access requirements to luminaires for the purpose of routine maintenance is considered outside of normal general practice, the access procedure(s) shall be fully documented in the Operation and Maintenance manuals for the project and recorded as a ‘Residual Risk’ on the designers CDM risk assessment.

11.1.2 Lampholders

Lampholders and Lamp caps shall comply with the relevant parts of the following standards:

- BS EN 60061-1 & BS EN 60061-2 (Lampholders & Lamp Caps)
- BS EN 61184 (Bayonet Lampholders)
- BS 7895 (Bayonet Lampholders with Enhanced Safety)
- BS EN 60400 (Fluorescent Lampholders and Starter Holders)
- BS EN 60238 (Edison Screw Lampholders)

Metal lampholders must have an earth terminal

Lampholders must be securely fixed within the luminaire. Where a lampholder is suspended on a cord or cable, suitable cord/cable grips must be provided.

The phase conductor must be connected to the centre contact when using an Edison screw lampholder.

Unless otherwise indicated tungsten filament lamps shall be used with the following lampholders:

- Lamps up to 150W – bayonet B22d
- 200W lamps – Edison screw E27 2A
- Lamps > 300W – Edison screw 16A

11.1.3 Control Gear

All control gear (ballasts, starters/ignitors, drivers, transformers, electronics including dimming circuitry) shall be suitable for the lamp type, wattage and starting characteristics of the respective lamps.

All control gear shall comply with the relevant parts of the following standards:

- BS EN 61347 suite (lamp control gear)
- BS EN 60921 (ballasts for fluorescent lamps)
- BS EN 60923 (ballasts for discharge lamps)
- BS EN 60924 (D.C. supplied electronic ballasts for tubular fluorescent lamps, general requirements)
- BS EN 60925 (D.C. supplied electronic ballasts for tubular fluorescent lamps, performance requirements)
- BS EN 60927 (performance requirements for starting devices [other than glow starters])
- BS EN 60928 (A.C supplied electronic ballasts for tubular fluorescent lamps, performance requirements)
- BS EN 62386 suite (Digital Addressable Lighting Interface DALI specifications and requirements)

All lamp/luminaire control gear shall conform to the relevant parts of the following standards for EMC immunity, radio Interference and harmonic current emissions.

- BS EN 61547 (EMC immunity requirements for general lighting equipment)
- BS EN 55015 (limits and measurement of radio disturbance characteristics of electrical lighting and similar equipment)
- BS EN 61000-3-2 (limits for harmonic current emissions for equipment ≤ 16A per phase)

Capacitors used in luminaire control circuits shall comply with:

- BS EN 61048 (Auxiliaries for lamps. Capacitors for use in tubular fluorescent and other discharge circuits. General and safety requirements
- BS EN 61049 (Specification for capacitors for use in tubular fluorescent and other discharge lamp circuits. Performance requirements)

Remotely located lamp control gear shall be mounted in a suitable, accessible enclosure. The length of cable between control gear and lamp shall not exceed manufacturers recommendations.

Unless otherwise specified, high frequency control gear with instant/quick start shall be provided.

Unless otherwise specified, dimmable luminaires shall utilise the DALI control protocol as defined by BS EN IEC 62386.

11.1.4 Lamps

11.1.4.1 **General**

All luminaire types shall reference the replacement lamp manufacturer and catalogue/part number. (either as a schedule within the O&M Manual or as embedded data within the BIM model)

Luminaires shall be supplied with lamps of the correct:

- Type and Efficacy
- Wattage (W)
- Voltage (V)
- Colour Rendering Index (CRI)
- Colour Temperature (K)
- Beam Angle (°)
- Mounting angle/orientation (to suit luminaire/installation where applicable)

Lamps of the same type shall be supplied by the same manufacturer.

11.1.4.2 **LED lamps & Modules**

LED lamps shall comply with the relevant parts of the following standards:

- BS EN 62031 (LED modules for general lighting. Safety specifications)
- BS EN 62612 (Self-ballasted LED lamps for general lighting with supply voltages > 50V. Performance requirements)

The light output of LED lamps, modules and luminaires shall be measured and presented in accordance with BS EN 13032-4.

LED lamps, modules & luminaires shall have suitable heat sinks to limit the operating temperature of the LEDs. LED light output should typically be maintained above 70% of its initial light output after 50,000 hours of operation and have a suitable luminous flux deviation to maintain performance. (Minimum recommended lumen performance L70, B50 @ 50,000 hours)

LED drivers shall be selected and incorporate suitable heatsinks to either:

- limit their operating temperature to 50% the manufacturers recommended maximum operating temperature.
- ensure that the expected life of the LED driver is at least equal to that of the LEDs which it powers (or to de-rate the LEDs recommended performance (hours) to that of the driver)

Dimmable LED drivers shall utilise either Constant Current Reduction (CCR) or Pulse-width Modulation (PWM) technologies depending on the overall Lighting Control strategy. Where PWM technology is employed it shall switch the wave at the “Trailing Edge”. CCR dimming may be preferred where Supply Quality is a concern, PWM dimming is preferable where colour rendering needs to be maintained at all brightness levels.

11.1.4.3 **Fluorescent Lamps & Compact Fluorescent Lamps**
Fluorescent lamps shall comply with the relevant parts of the following standards:

- BS EN 60081 (Double-capped fluorescent lamps. Performance Standards)
- BE EN 60901 (Single-capped fluorescent lamps. Performance Standards)
- BS EN 61195 (Double-capped fluorescent lamps. Safety specifications)
- BS EN 61199 (Single-capped fluorescent lamps. Safety specifications)
- BS EN 60968 (Self-ballasted fluorescent lamps for general lighting services. Safety requirements)
- BS EN 60969 (Self-ballasted fluorescent lamps for general lighting services. Performance requirements)
- BS 1853-2 (Tubular fluorescent lamps for general lighting. Specification for lamps used in the United Kingdom)

Unless otherwise specified all linear fluorescent lamps shall be tri-phosphor.

11.1.4.4 **Metal Halide Discharge Lamps**
Metal Halide lamps shall comply with the relevant parts of the following standards:

- BS EN 61167 (Metal halide lamps. Performance specification)
- BS EN 61549 (Miscellaneous lamps)
- BS EN 62035 (Discharge lamps [excluding fluorescent lamps]. Safety specifications)

11.1.4.5 **High pressure Sodium Discharge Lamps**
High pressure sodium lamps shall comply with the relevant parts of the following standards:

- BS EN 60662 (High pressure sodium vapour lamps, Performance specification)
- BS EN 62035 (Discharge lamps [excluding fluorescent lamps]. Safety specifications)

11.1.4.6 **Low pressure Sodium Discharge Lamps**
Low pressure sodium vapour lamps shall comply with the relevant parts of the following standards:

- BS EN 60192 (Low pressure sodium vapour lamps, Performance specification)
- BS EN 62035 (Discharge lamps [excluding fluorescent lamps]. Safety specifications)

11.1.4.7 **High pressure Mercury Discharge Lamps**
High pressure mercury vapour lamps shall comply with the relevant parts of the following standards:

- BS EN 60188 (High pressure mercury vapour lamps, Performance specification)
- BS EN 62035 (Discharge lamps [excluding fluorescent lamps]. Safety specifications)

11.1.4.8 **Tungsten Halogen Lamps**
Tungsten Halogen lamps shall comply with the relevant parts of the following standards:

- BS EN 60432-2 (Tungsten halogen lamps for domestic and similar general lighting purposes)

- BS EN 60357 (Tungsten halogen lamps [non-vehicle]. Performance specifications)

11.1.4.9 **Tungsten Filament Lamps**

Tungsten filament lamps shall comply with the relevant parts of the following standards:

- BS EN 60432-1 (Incandescent lamps. Safety specifications. Tungsten filament lamps for domestic and similar general lighting purposes)
- BS EN 60630 (maximum lamp outliners for incandescent lamps)
- BS EN 61549 (Miscellaneous lamps)

11.1.4.10 **Cold Cathode**

Cold cathode luminaires and lighting systems shall be manufactured in accordance with BS EN 50107-3

11.1.4.11 **Neon Lighting**

Neon luminaires and high voltage discharge display signs and decorative lighting shall comply with:

- BS EN 50107-1 (BS EN 50107-1:2002. Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. General requirements)
- BS EN 50107-2 (BS EN 50107-2:2005. Signs and luminous-discharge-tube installations operating from a no-load rated output voltage exceeding 1 kV but not exceeding 10 kV. Requirements for earth-leakage and open-circuit protective devices)
- BS 559 (BS 559:2009. Specification for the design and construction of signs for publicity, decorative and general purposes.

External lighting operating at voltages exceeding low voltage shall be provided with a firefighters's switch arrangement as required by BS 7671. The firefighter's switch shall comply with BS EN 60669-2 or BS EN 60947-3.

11.1.5 Luminaire Supports and Fixings

All luminaires shall be physically supported in accordance with manufacturers recommended instructions. Where the weight of the luminaire is carried by a secondary assembly (e.g. a suspended ceiling or boarded bulkhead or partition) confirmation of it's suitability to support the luminaire(s) shall be sought from the installer or project architect/structural engineer. Additional support for luminaires will only be included when specifically required by the luminaire manufacturer.

All luminaires shall be fitted with secondary support straps for covers, diffusers and control gear trays so they are prevented from falling when the primary fixings are released.

Luminaires recessed into suspended ceilings or boarded hollow constructions shall be connected to the lighting circuit by means of a flexible cable or conduit. Where final connection plug and sockets are utilised they shall comply with the relevant sections of BS 6972 and BS 5733.

Where recessed luminaires are embedded or cast into the building fabric/plaster (using a removable backbox or enclosure), the connection to the electrical supply shall be via a rewireable containment system such as mechanically coupled conduit.

Surface mounted or suspended luminaires shall be installed and supported using one of the following methods:

- **Direct fixing** to a ceiling, wall or bracket using appropriate fixings. Where a surface luminaire is fixed to plasterboard, a removable ceiling tile or hollow boarded construction suitable battens shall utilised. The electrical connection shall be via flexible cable (using appropriate compression gland) or mechanically coupled conduit/flexible conduit. (see note below)
- **Trunking mounted** using proprietary clamps and brackets. The electrical connection shall be via single cables through proprietary bush and locknut arrangement. (see note below)
- **Conduit mounted** - Luminaires shall be fixed to suitably spaced and supported galvanised metal conduit boxes using M4 brass or galvanised pan head screws and washers. The electrical connection shall be through the direct conduit coupling. (see note below)
- **Conduit Ball and Socket(S)** - A proprietary (single or pair to suit luminaire) galvanised steel conduit ball and socket shall be fitted onto suitably supported conduit box. A conduit drop (not exceeding a single length of conduit) shall support the luminaire. Connection to the luminaire shall be either by direct connection of the conduit using locknuts (either side of luminaire) and a female brass bush, or by using a threaded back-outlet box and M4 brass or galvanised pan head screws. Where the body of the luminaire requires drilling, locknuts and female bush shall be used. Where the luminaire is IP rated, suitable sealing washers shall be used to ensure the required IP rating is not compromised. (see note below)
- **Suspended on Rod, Steel Wire or Chain** – Proprietary hangers with appropriate load bearing capacity and suitable fixings shall be utilised to anchor the rod, wire or chain connectors to the supporting structure, and to the body of the luminaire. The electrical connection to the luminaire shall be via flexible cable (using appropriate compression gland) or mechanically coupled conduit/flexible conduit. (see note below). Where steel wire is used it shall comply with BS EN12385-1, BS EN 13411-3 & BS EN 13411-4. Where chain or threaded rod is used it shall protected/coated against corrosion and have a load bearing capacity of not less than twice the total weight of the luminaire.
- **Suspended on Flexible cord** - Flexible cord shall be suitable sized to support the physical weight and electrical load of the luminaire. Electrical cord shall be suitable for continual use at the maximum operating temperature of the luminaire or lampholder. Proprietary cord grips shall be fitted at both ends of the cord to ensure the electrical terminations are free from any strain.
- **Column mounted Luminaires** - Only lighting columns designed, manufactured and testing in accordance with BS EN 40 (all relevant parts), and complying with the safety and performance requirements of BS EN 12767 shall be used. Lighting column manufacturers shall be consulted in respect of column selection and suitability for each specific application. All lighting columns shall be installed strictly in accordance with the manufacturer's instructions and recommendations. All required civils work shall be undertaken by the project main contractor who shall consult a suitably qualified structural engineer to design and specify any required column foundations. The electrical supply to lighting columns shall be via ducted SWA cables as detailed on the electrical design engineers cable schedules. SWA cables shall be terminated within the base of the column at a cutout manufactured to BS 7654. A suitable length of fixed/flexible cable shall be routed inside the column form the cutout to the luminaire (see note below). Where installed roadside column access covers/doors shall face away from the roadway.

Note: Where fixed wiring is routed through the body of a luminaire, heat resistant protective sleeving may be required. Consult with the luminaire manufacturer for specific requirements. Alternatively, cables may be terminated within the conduit box and a short length of heat resistant cable used to make the final connection to the luminaire.

11.1.6 Floodlights

Floodlights shall meet the requirements of:

- BS EN 60598-2-5 (Luminaires. Particular requirements. Floodlights)

Floodlights shall be positioned and oriented to avoid direct upward light.

11.1.7 Hazardous Area Luminaires

Hazardous Area Luminaires shall comply with the relevant parts of the following standard series:

- BS EN 60079 [series](Explosive atmospheres)

11.1.8 Installation and workmanship

Luminaires shall be installed at the heights and positions as indicated on the approved coordinated/working drawings.

All luminaires shall be securely supported in-line with the manufacturer's recommendations

All diffusers shall correctly inserted (using retaining clips where provided), diffusers shall be cleaned and free of dust and grease.

All fixing screws shall be in place and firmly secured.

Flexible cables and cords supplying power/control to the luminaires shall be appropriately terminated and restrained.

Lamps shall be handled using disposable gloves, any grease or dirt on the glass of lamps shall be cleaning in accordance with manufacturer's instructions.

Luminaires shall not be covered with insulating material and all air vents shall be clear of obstructions.

11.2 Emergency Lighting & Luminaires

11.2.1 General

Emergency lighting luminaires shall comply with the following standards and requirements:

- BS EN 60598-2-22 (Luminaires, particular requirements. Luminaires for emergency lighting.

- ICEL 1001 All emergency luminaires shall be marked with the ICEL certification.

Emergency escape lighting systems will be provided in accordance with BS EN 50172 and the relevant parts of BS5266

The conversion of a normal luminaire to an emergency luminaire must be undertaken by the luminaire manufacturer using approved certified products. The manufacturer shall undertake all the required safety, functional and performance tests and re-certify the luminaire (i.e. CE marking, photometry)

In the event of loss of the mains electricity, emergency lighting will be maintained at the required levels for a period of 3 hours or as risk assessed by a competent person.

The alternative power supply to the emergency lighting system will be derived from:

- A central battery unit complying with BS EN 50171
- A self contained power pack complying with BS EN 60598-2-22

11.2.2 Minimum illuminance levels

Minimum emergency lighting levels will conform to the requirements of:

- BS EN 1838 (Lighting applications – emergency lighting)
- BS 5266-1 (Code of practice for the emergency lighting of premises)

(Notes: For minimum emergency lighting levels refer to section 4 (BS EN 1838), and section 5 (BS 5266-1). Refer to Annex E table E.1 of BS 5266-1 for emergency lighting levels for specific locations)

11.2.3 Central Battery Emergency Luminaires

BS EN 50171

HD 384 (BS 7671)

11.2.4 Illuminated Exit Signs

Emergency illuminated exit signs shall comply with the following standards and requirements:

- BS EN 5499-3 (Fire safety signs, notices and graphic symbols. Specification for internally-illuminated fire safety signs)
- BS EN 5499-4 (Code of Practice for Escape Route Signage
- BS EN ISO 7010 (Graphical symbols. Safety colours and safety signs. Registered safety signs)

11.2.5 Photoluminescent / Phosphorescent / Externally Illuminated signs

Photoluminescent / Phosphorescent / Externally Illuminated signs shall comply with the following requirements:

- BS ISO 3864-4

11.2.6 Emergency Lighting system Test Facility

A test facility will be provided for each emergency lighting system having an appropriate means of simulating failure of the normal power supply through manual isolation or automatic testing in compliance with BS 5266 the below requirements:

- The test facility should be able to be used for all periodic tests (monthly and annual)

- The test facility should be protected from unauthorized operation
- Power should not be interrupted to any other electrical equipment which could cause a hazard when under test conditions

11.2.7 Wiring and Cabling

Self-contained emergency luminaires do not require fire-protected cable supplies and should be installed to the same standard as normal luminaires, complying with the following standards:

- BS EN 50171
- HD 384 (BS 7671)

Emergency lighting luminaires connected to a central power supply should have cables and/or cable systems which adequately resist the effects of fire and mechanical damage and retain circuit integrity. Cables and cable systems should conform to the methods as detailed below.

Emergency lighting cables with an inherently high resistance to attack by fire having minimum survival duration of:

- 60 minutes when tested in accordance with BS EN 50200:2015 (class PH 60 - BS EN 50200:2015); and
- 30 minutes when tested in accordance with BS EN 50200:2015, Annex E.

The cabling should also conform to one of the following standards:

- BS EN 60702-1 & BS EN 60702-2
- BS 7629-1
- BS 7846.

Enhanced emergency lighting cables with an inherently high resistance to attack by fire having minimum survival duration of:

- 120 minutes when tested in accordance with BS EN 50200:2015 (class PH 120 - BS EN 50200:2015, Annex D); and
- 120 minutes when tested in accordance with BS 8434-2

The cabling should also conform to one of the following standards:

- BS EN 60702-1 & BS EN 60702-2
- BS 7629-1
- BS 7846.

Emergency lighting cable systems with an inherently high resistance to attack by fire, comprising of fire-resistant single core or multi-core cables enclosed in screwed steel conduit, where the below requirements are met:

- Cable system has a duration of survival of 60 minutes
- Cables meet the requirements of IEC 60331-3 for a flame application time of 60 minutes
- Single core cables compliant with BS 8592

Enhanced emergency lighting cable systems with an inherently high resistance to attack by fire, comprising of fire-resistant single core or multi-core cables enclosed in screwed steel conduit, where the below requirements are met:

- Cable system has a duration of survival of 120 minutes

- Cables meet the requirements of IEC 60331-3 for a flame application time of 120 minutes
- Single core cables compliant with BS 8592

11.2.8 Wiring and Cabling support systems

The electrical containment and associated supports and fixings for that carry emergency lighting cables should be capable of withstanding fire conditions equal to that of the cable being used.

(Note: according to BS 7671 Steel containment systems are deemed to satisfy this requirement)

Where cable management system support is provided by drop rods, either alone or in conjunction with other support methods, the drop rod size should be calculated in accordance with BS 8519.

11.3 Lighting Controls

11.3.1 General

The lighting control system will be selected to suit the application and client requirements. Many of the functions below can be integrated into an overall automated lighting control system

- Manual Control – manual switches
- Manual Local Scene Selection – local manual control
- Timeclock Control – automated on/off control
- PIR – presence detection / absence detection
- Daylight Linked – ON/OFF switching at predefined light levels
- Daylight Dimming – Lighting dimmed in response to daylight contribution

Unless otherwise specified all luminaire ballasts (requiring dimming control and/or integrated monitoring) shall be of the Digital Addressable Lighting Interface (DALI) type as defined by BS EN 62386 [series].

Whilst the luminaries shall operate using the DALI protocol. The control system backbone can be any open protocol system capable of interfacing and integrating with DALI.

The lighting control system shall be capable expansion and reconfiguration without loss of functionality to existing areas of the lighting system.

The lighting control system shall be capable of operating without a central/area controller being connected.

12 Electrical Accessories

12.1 Isolators, Disconnectors and Fuse-combination units

Isolators, disconnectors and fuse-combination units shall comply with the relevant parts of:

- BS EN 60947-3 (Low-voltage switchgear and controlgear. Switches, disconnectors, switch-disconnectors and fuse-combination units)

Isolators, disconnectors and fuse-combination units shall be securely mounted at a suitable height with sufficient space to allow access and maintenance.

Where units incorporate flex outlets, suitable cable restraints / anchoring clamps shall be fitted.

12.2 Contactors and Starters

Contactors and motor starters shall comply with the relevant parts of:

- BS EN 60947-1 (Low-voltage switchgear and controlgear. General rules)
- BS EN 60947-4-1 (Low-voltage switchgear and controlgear. Contactors and motor-starters. Electromechanical contactors and motor-starters)
- BS EN 60947-4-2 (Low-voltage switchgear and controlgear. Contactors and motor-starters. AC semiconductor motor controllers and starters)
- BS EN 60947-4-3 (Low-voltage switchgear and controlgear. Contactors and motor-starters. AC semiconductor controllers and contactors for non-motor loads)

Assemblies housing low-voltage switchgear and control gear shall comply with:

- BS EN 61439-1 (Low-voltage switchgear and controlgear assemblies. Part 1. General Rules)
- BS EN 61439-2 (Low-voltage switchgear and controlgear assemblies. Power switchgear and controlgear assemblies)

Motors 0.37kW or greater shall have starters incorporating overcurrent protection.

12.3 Power Outlets and Adapters

13A Socket Outlets shall comply with:

- BS 1363-2 (13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A switched and unswitched socket-outlets)

Note: Socket outlets on circuits having (or expecting to have) high protective conductor currents must comply with regulation 543.7 of BS 7671 and may require 2 separate CPC terminals.

13A Connectors and Adapters shall comply with:

- BS 1363-3 (13 A plugs, socket-outlets, adaptors and connection units. Specification for adaptors)

13A Fused Connection units shall comply with:

- BS 1363-4 (13 A plugs, socket-outlets, adaptors and connection units. Specification for 13 A fused connection units switched and unswitched)

Industrial Socket Outlets shall comply with the relevant parts of:

- BS EN 60309-1 (Plugs, socket-outlets and couplers for industrial purposes. General requirements)
- BS EN 60309-2 (Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories)
- BS EN 60309-4 (Plugs, socket-outlets and couplers for industrial purposes. Switched socket-outlets and connectors with or without interlock)

Combined RCD and Socket Outlets shall comply with:

- BS 7288 (Specification for residual current devices with or without overcurrent protection for socket-outlets for household and similar uses)

Cooker Outlets shall comply with:

- BS 4177 (Specification for cooker control units)

Unless otherwise specified or indicated, general socket outlets on walls shall be mounted at a height of 450mm from finished floor level to the centre line of the socket. Where the socket outlet is above a table or worktop the mounting heights will be agreed with the architect.

12.4 Switches

Switches and light switches shall comply with the relevant requirements of:

- BS EN 60669-1 (Switches for household and similar fixed-electrical installations. General requirements)
- BS EN 60669-2-1 (Switches for household and similar fixed electrical installations. Particular requirements. Electronic switches)
- BS EN 60669-2-2 (Switches for household and similar fixed electrical installations. Particular requirements. Electromagnetic remote-control switches (RCS))
- BS EN 60669-2-3 (Switches for household and similar fixed electrical installations. Particular requirements. Time-delay switches (TDS))
- BS EN 60669-2-4 (Switches for household and similar fixed electrical installations. Particular requirements)
- BS EN 60669-2-5 (Switches for household and similar fixed electrical installations. Particular requirements. Switches and related accessories for use in home and building electronic systems (HBES))
- BS EN 60669-2-6 (Switches for household and similar fixed electrical installations. Particular requirements. Fireman's switches for exterior and interior signs and luminaires)
- BS EN 60730-2-7 (Automatic electrical controls for household and similar use. Particular requirements for timers and time switches)

Unless otherwise specified light switches shall be mounted at a height of 1200mm from finished floor level to the centre line of the switch.

12.5 Data and Telecommunication Outlets

Data and telecommunication outlets shall:

- Use RJ45 sockets
- Be suitable for Ethernet Cat 5, Cat 5e, Cat 6 or Cat 7
- Have faceplates suitable for connection to BS 4662 backbox.

BT type outlets using 431A type jacks shall comply with:

- BS 6312-1 (Connectors for analogue telecommunication interfaces. Specification for plugs)
- BS 6312-2.2 (Connectors for analogue telecommunication interfaces. Sockets for use with plugs specified in BS 6312-1. Particular requirements for fixed socket-outlets used in permanent wiring installations)

Where Cat 5 and above ethernet LAN cables are terminated in wall plates (and patch panels) the termination colour coding standard EIA/TIA 568B shall be adopted (except where existing wiring has used a different colour coding scheme, in which case additions to the network should adopt the existing standard)

12.6 Shaver Sockets

Shaver sockets shall comply with the requirements of:

- BS EN 61558-2-5 (Safety of transformers, reactors, power supply units and combinations thereof. Particular requirements and tests for transformer for shavers, power supply units for shavers and shaver supply units)

Shaver sockets shall have both 115V and 230V outputs (clearly identified) and be engraved with the words “SHAVERS ONLY” and/or contain the internationally recognized graphical symbol.

12.7 RF and Coaxial Outlets

RF and Coaxial outlets shall comply with the relevant parts of:

- BS 3041 (Radio frequency connectors)
- BS EN 60169 series (Radio frequency connectors)

12.8 Backboxes

Backboxes for mounting of electrical accessories shall comply with:

- BS 4662 (Boxes for flush mounting of electrical accessories. Requirements, test methods and dimensions)
- BS EN 60670-1 (Boxes and enclosures for electrical accessories for household and similar fixed electrical installations. General requirements)

Recessed backboxes (both single and twin) shall have a minimum of 2 x 25mm knockouts on one of the 72mm sides.

Recessed backboxes shall be securely fixed to the building fabric, where fitted within partition walls a wooden or proprietary batten shall be provided. Alternatively, a dry lining backbox shall be used.

Backboxes shall be selected with an appropriate depth to ensure sufficient space is available to accommodate cables.

13 Fire Alarm Systems

13.1 General

Fire Alarm systems shall be designed and installed inline with the following standards:

- BS 5839-1 (Fire detection and fire alarm systems for buildings. Part 1 non-domestic buildings)
- BS 5839-6 (Fire detection and alarm systems for buildings. Part 6 domestic premises)
- BS 5839-8 (Fire detection and alarm systems for buildings. Part 8 voice alarm systems)
- BS 6266 (Fire protection for electronic equipment in installations)
- BS EN 60849 (Sound systems for emergency purposes)

13.2 Control Panels

Fire alarm control, panels shall be designed, manufactured and tested in accordance with:

- BS EN 54-2 (Control and indicating equipment)
- BS EN 50130-4 (Alarm systems – Electromagnetic compatibility)

The location and position of the Main Fire Alarm control panel, and all mimic and repeater panels shall be agreed with both the architect and fire officer.

Where required a fireman's switching and control panel shall be provided at the main fire alarm panel to allow the attending fire officer to control specified fire related plant and equipment.

A zone diagram of the overall fire alarm system shall be displayed adjacent to the main fire alarm panel.

13.3 Fire Detection

Fire alarm fire detection devices shall be designed, manufactured and certified in accordance with the relevant standards below:

- BS EN 54-5 (Heat detectors)
- BS EN 54-7 (Smoke detectors)
- BS-EN 54-10 (Flame detectors)
- BS-EN 54-11 (Manual call points)
- BS-EN 54-12 (Beam detectors)
- BS EN 54-20 (Aspirating smoke detectors)
- BS EN 54-22 (Resettable line type heat detectors)
- BS EN 54-26 (Carbon monoxide sensor)
- BS EN 54-27 (Duct smoke detectors)

- BE EN 54-28 (Non-resettable line type heat detectors)
- BS EN 54-29 (Multi-sensor detector - smoke and heat)
- BS EN 54-30 (Multi-sensor detector –carbon monoxide and heat)
- BS EN 54-31 (Multi-sensor detector – smoke, carbon monoxide and heat)
- BS EN 50130-4 (Alarm systems – Electromagnetic compatibility)

All point detectors shall utilise the same type base and be interchangeable. Removal of any sensor shall display a system fault on the main control panel but not render any part of the system inoperable.

All fire alarm detectors and sensors shall be analogue in performance and use digital protocols to communicate with the rest of the system.

13.4 Alarms / Sounders / Loudspeakers

Fire alarm sounders shall be designed, manufactured and certified in accordance with the following standard:

- BS EN 54-3 (Fire alarm devices - Sounders)

Voice alarm system loudspeakers shall be designed, manufactured and certified in accordance with the relevant parts of:

- BS EN 54-24 (Fire alarm devices – Visual alarm devices)

Visual alarm devices shall be designed, manufactured and certified in accordance with:

- BS EN 54-23 (Components of voice alarm system – Loudspeakers)

13.5 Interfaces / Ancillaries

Fire alarm interfaces and ancillary devices be designed, manufactured and certified in accordance with the relevant standards below:

- BS EN 54-4 (Control and indicating equipment)
- BS EN 54-4 (Power supply equipment)
- BS EN 54-17 (Short-circuit isolators)
- BS EN 54-18 (Input/output devices)
- BS EN 54-11 (Manual call points)
- BS EN 54-21 (Fire detection and fire alarm systems. Alarm transmission and fault warning routing equipment)
- BS EN 54-24 (Fire alarm devices – Visual alarm devices)
- BS EN 1155 (Electrically powered hold-open devices for swing doors - Requirements and test methods)
- BS EN 1634 (Fire resistance and smoke control tests for door and shutter assemblies)

13.6 Voice Evacuation Systems

Fire alarm voice alarm control and indicating equipment shall be designed, manufactured and tested in accordance with the relevant standards below:

- BS EN 54-4 (Power supply equipment)
- BS EN 54-4 (Control and indicating equipment)

- BS EN 54-16 (Voice alarm control and indicating equipment)
- BS EN 54-23 (Components of voice alarm system – Loudspeakers)

13.7 Gas Suppression Systems

Fire Fighting Gas Suppression systems shall be designed, installed and maintained in accordance with the relevant parts of the following standards:

- BS EN 15004-1 (Fixed firefighting systems. Gas extinguishing systems. Design, installation and maintenance)
- BS EN 15004 parts 2 to 10 (Fixed firefighting systems. Gas extinguishing systems. Physical properties and system design of gas extinguishing systems for [particular] extinguishant)

13.8 Wiring and Cabling

Fire alarm systems shall be wired in ‘Standard’ or ‘Enhanced’ fire resistant cable. For the majority of Fire alarm installation ‘Standard’ cable is deemed sufficient. Examples of where ‘Enhanced’ fire resisting cables shall be used include:

- Un-sprinklered buildings where the ‘Fire Plan’ involves evacuating building occupants in four or more phases.
- Un-sprinklered buildings greater than 30m in height
- Un-sprinklered buildings or large networked sites where a fire could affect the cables critical path, and in particular where people remain in occupation elsewhere on the site during a fire.
- Where a delayed evacuation may exist and the fire alarm cables pass through an area of high risk.
- Where a project specific risk assessment has identified the need for using enhanced cable.

Cables requiring ‘Standard’ resistance to attack by fire shall have a minimum survival duration of:

- 30 minutes when tested in accordance with BS EN 50200:2015, Annex E.
- 30 minutes when tested in accordance with BS 8434-1

Cables requiring ‘Enhanced’ resistance to attack by fire shall have a minimum survival duration of:

- 120 minutes when tested in accordance with BS EN 50200:2015 (class PH 120 - BS EN 50200:2015, Annex D); and
- 120 minutes when tested in accordance with BS 8434-2

‘Standard’ and ‘Enhanced’ shall also conform to one of the following standards:

- BS EN 60702-1 & BS EN 60702-2
- BS 7629-1

14 NG Bailey Approved and Preferred Manufacturers / Supply Chain

NG Bailey work closely with the supply chain to ensure:

- Products and systems installed on our projects meet necessary technical standards.
- Quality and reliability of products and systems installed are fit for their intended purpose and meet NG Bailey minimum standards.
- Specialist sub-contractors employed adhere to our processes and procedures (e.g. Safety, Quality Assurance, Quality Control Safety and Commissioning etc.)
- Suppliers and sub-contractors have the required competence, capacity, availability and logistics to furnish our projects without compromising the project delivery programme.

All NG Bailey approved “commodity” items are listed and available on our electronic e-procurement system @ MyMaterials

A list of our approved/preferred suppliers and sub-contractors is available @ MySupplyChain

In the absence of a specific project or client requirement, all products, systems and services utilised on NG Bailey projects shall be procured from the NG Bailey approved supply chain. When in doubt please consult with our procurement and technical departments.

MyMaterials and MySupplyChain contain a wide range of NG Bailey approved products/services to suit the particular requirements of a client or project. Where products have been selected specifically to meet a client’s requirements such particular product(s/services) shall be named within the project bid.