African Development Bank Group

African Development Bank's Field Office in Abuja, Nigeria

LOT 3: VOL 2-2 - SPECIFICATIONS FOR THE INSTALLATION OF ELECTRICAL WORKS.

Prepared by Interstate Architects Ltd.

In Conjunction with: IAA Associates Ltd.
KOA Associates Ltd. & Construction Economists Partnership Ltd.
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INTRODUCTION

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NOTES FOR TENDERERS

This specification is in three sections:-

SECTION 1 - PRELIMINARIES

The Preliminary clauses included are those that relate to the Engineering Works in particular and must be read in conjunction with the "Preliminaries" of the "Head Contract".

SECTION 2 - SYSTEM SPECIFICATIONS

The system specifications are sub-divided into three parts:-

Part 1 - System objectives

The system objectives are clauses giving details of design information, system performance and description, together with lists of the system schematics and drawings.

Part 2 - Selection schedules for the reference specifications

These selection schedules specify items in the system that are contained in the Reference Specifications (Y group). Required Y Group clauses are invoked by reference.

Part 3 - Clauses specific to the system

These specification clauses are specific to the system concerned and make no reference to the Y group clauses.
SECTION 3 - REFERENCE SPECIFICATIONS (Clauses from the Y group)

This section contains all the reference specifications relevant to all the systems for the job. Required clauses are invoked in Part 2 (Selection schedules for the reference specifications) for each system.

NON-NES CLAUSES

Non-NES clauses may appear in Preliminaries, Selection Schedules and Clauses Specific to the Systems.

They will be distinguished by the clause reference beginning with an "alpha" character.
A10 PROJECT PARTICULARS

1100 THE PROJECT:
Particulars of the project as a whole are given in Main Contract Preliminaries.

1200 THE CLIENT:
African Development Bank

1300 TECHNICAL CONTROL CONSULTANTS:
AIM Consultants Limited

1400 DESIGN TEAM (DT):
Co-ordinating Consultant / Architect
Interstate Architects Limited
45, Muritala Moh’d Intl. Airport Road
Ajao Estate, Lagos.
Tel.: +234 (01) 7741500
E-mail: interstate@interstatearchitects.com

In conjunction with the following sub-consultants:
Quantity Surveyor
C. E. P. Limited
1b, Tafawa Balewa Crescent
Off Adeniran ogunsanya Street
Surulere, Lagos
Tel.: +234 (01) 7227266
E-mail: con_ep@yahoo.co.uk

Structural Engineer
I.A.A. Associates Limited
Laplace House
Block III, Plot 3, Oniru Estate
Victoria Island, Lagos
Tel.: +234 (01) 7731029
E-mail: info@iaaassociates.com

Electrical & Mechanical Services Engineer
KOA CONSULTANTS Ltd
12a Morris Street, Abule-Ijesha
Yaba, Lagos
Tel.: +234 1 7611229
E-mail: koa@koaconsultants.com

AfDB: Electrical Specifications
1700  **SUBCONTRACTOR:**
The term Subcontractor is used throughout this specification and is deemed to be synonymous with the term Subtrader and the like which may be used elsewhere within the Contract Documentation.

1800  **THE SUBCONTRACT:**
The Engineering Services Installations covered by this Subcontract comprise: Electrical Services Installations as shown on the drawings and described in Section 2 of this Specification
A11 DRAWINGS

1100 THE TENDER DRAWINGS:
The tender drawings are indicated in the schedules of drawings.

1200 THE SUBCONTRACT DRAWINGS:
The subcontract drawings are the same as the tender drawings.

1400 INSPECTION:
Inspect all drawings and other documents relating to the Contract prior to the submission of tender.
A12 THE SITE

1100 THE SITE BUILDINGS:
The site is described in Main Contract Preliminaries.

1200 SITE LOCATION:
The site is located at the central district in Abuja.

1500 SURVEY:
Ascertain the nature of the site and all local conditions and restrictions likely to affect the execution of the Works.

Examine all available drawings of the engineering services and report any discrepancies to the Bank.

1700 SITE VISIT:
Site visit may be made by the Subcontractor on agreement with the Bank.
A13 DESCRIPTION OF THE WORK

1100 THE MAIN CONTRACT WORK:
The main contract work is described in Main Contract Preliminaries.

1200 THE BUILDING:
Is a concrete structure building.
Refer to Architectural and Structural drawings for full details.

1400 THE SUBCONTRACT WORK:
Supply, install, balance, verify, test, commission and maintain the building services installations defined in the Work Sections and drawings listed in the schedules

1500 WORK BY OTHERS AND CO-ORDINATION OF TRades:
Allow for co-ordinating the subcontract works with the works of other trades and installations which may be on site during the period of the subcontract.

1600 COMPLETION WORK BY OTHERS:
Builder's work except as stated in Clause 1900 of Section A31.
Decorative painting

1700 COMMON DESIGN CRITERIA:
The criteria listed in the following clauses apply to all Work Sections included in the Subcontract unless specified otherwise.

1800 OUTSIDE CONDITIONS:
max temp   -38°C
design temp -38°C

1900 INSIDE CONDITIONS:
temp   :24°C ± 2°C DB
humidity :50% ± 10% RH

2000 ELECTRICAL SUPPLY:
11000/400V - 3ph - 50Hz

AfDB: Electrical Specifications
2100 PLANT OPERATING CONDITIONS:
Ensure all plant items are suitable for operation in the environment in which they are to be located with the environment as specified below:
  Internal
    Temperature 22°C to 40°C
  External
    Temperature 18°C to 40°C
    Humidity (% rh) 60 to 100
    Protect equipment to BS EN 60529
    IP 65 or as specified.

2200 ELECTROMAGNETIC COMPATIBILITY:
Ensure all equipment and systems are installed to provide electromagnetic compatibility within the system and with any other systems installed in the same area.
Ensure all systems and buildings are assessed for protection to, and that such protection meets the requirements of, BS 62305. Ensure all equipment meets the requirements of the appropriate electromagnetic compatibility standard.
A20 THE CONTRACT/SUBCONTRACT

1100 MAIN CONTRACT PARTICULARS:
The Main Contract particulars are given in relevant sections of the Main Contract Preliminaries.

1300 SUBCONTRACT GUARANTEE BOND:
Ensure compatibility with the Main Contract guarantee bond and the Bank’s bond requirements.
A30 TENDERING/SUB-LETTING/SUPPLY

SUBCONTRACT TENDERING

1100 SCOPE:

These conditions are supplementary to those stated in the invitation to tender and on the Form of Tender and Agreement.

1300 EXCLUSIONS:
If the Subcontractor cannot tender for any part(s) of the work as defined in the tender documents, he must inform the PM / CC as soon as possible, defining the relevant part(s) and stating the reasons for his inability to tender.

1400 ACCEPTANCE OF TENDER:
The Bank and his representatives:
   i) Offer no guarantee that the lowest, or any tender, will be recommended for acceptance or accepted.
   ii) Will not be responsible for any cost incurred in the preparation of any tender.

1500 PERIOD FOR ISSUE OF NOMINATION INSTRUCTIONS:
Where a minimum period has been stipulated in the Invitation to Tender, it must not be altered by the Subcontractor without prior approval.

1600 SITE VISIT:
Before tendering, ascertain the nature of the site, access thereto and all local conditions and restrictions likely to affect the execution of the Subcontract Works.
PRICING/SUBMISSION OF DOCUMENTS

2700 SUBCONTRACT SPECIFICATION WITHOUT QUANTITIES:
Where and to the extent that quantities are not included in the specification, tenders must include for all work shown or described in the tender documents as a whole or clearly apparent as being necessary for the complete and proper execution of the Works.

2800 PRICING OF SUBCONTRACT SPECIFICATION:
Alterations and qualifications to the specification must not be made without the written consent of the Bank. Tenders containing such alterations or qualifications may be rejected. Costs relating to items in the specification which are not priced will be deemed to have been included elsewhere in the tender.

3120 A SCHEDULE OF RATES:
A (quantified) schedule of rates as referred to in the Form of Tender must be submitted with the Tender.
It must include all items and materials included in the tender, together with their rates, extended and totaled. Preliminaries are to be separately priced. Such totals shall agree with the Subcontract Sum and subtotals shall agree with the priced breakdown of the tender. Correction of errors in the quantification will not lead to adjustment of the Subcontract Sum.

3400 DAYWORK PERCENTAGES:
Contractor shall Indicate his daywork percentages for both labour and materials

3800 ALTERNATIVE MANUFACTURERS/SUPPLIERS:
In addition to and at the same time as his tender for the Subcontract Works as defined in the tender documents, the Subcontractor may, at his discretion, submit alternative manufacturers or suppliers for consideration.

Alternatives which would involve significant changes to other work will not be considered.

Such alternative(s) must include all additional costs arising from necessary changes to the details of the installation, including changes to the design and drawings, as well as any associated ancillary equipment items.
Such alternative(s) is/are deemed to be alternative tender(s) and each must include a complete and precise statement of the effects on cost and programme. Full technical data for each such alternative must be submitted with the Tender together with details of any consequential amendments to the design and/or construction/installation of other parts of the Works.

3900 SELECTION OF MANUFACTURERS/SUPPLIERS:
Where manufacturers, suppliers or installers of products are NOT identified by name, select products that comply in all respects with the specification and, as and when requested, demonstrate such compliance.

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

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

Check that any proposed alternatives comply with any stated British (or other equivalent recognised International) Standards. Confirm equivalence in quality, operation and space requirements to those items which have been specified by name.
If, and when requested demonstrate the proposed alternative is fully equivalent to the specified item and identify any constructional, cost, programme, maintenance or other differences.

4000 A LIST OF PROPOSED MANUFACTURERS/SUPPLIERS:
A list of proposed manufacturers/supplies of products, equipment and plant, including all items for which the choice of manufacturer/supplier is at the discretion of the Subcontractor, must be submitted with the Tender.

4100 TECHNICAL INFORMATION:
Technical information relating to the Subcontractor's tender must be submitted with the Tender.
4200 QUALITY CONTROL RESOURCES:
A statement must be submitted with the Tender describing the organization and resources which the Subcontractor proposes and undertakes to provide to control the quality of the Subcontract Works. The statement must include the number and type of staff responsible for quality control, with details of their qualifications and duties.

5200 SUB-SUBCONTRACTORS:
Where the Subcontractor proposes to sublet any portion(s) of the Subcontract Works a list must be submitted with the Tender defining such portion(s) and giving, for each, the name and address of the proposed Sub-contractor.
A31 PROVISION, CONTENT AND USE OF DOCUMENTS

1000 DEFINITIONS AND INTERPRETATIONS

1100 MAIN CONTRACT PRELIMINARIES:
Definitions and interpretations given in Main Contract Preliminaries apply to the whole of the Works, including this Subcontract.
In the Case of conflicting statements the Subcontract Preliminaries will prevail.

1500 TENDER DOCUMENTS:
Tender documents means tender drawings listed in the schedules and specification prepared to enable competitive tenders for the Works to be obtained.
Not all items or matters referred to in the specification are indicated on the drawings nor are all items detailed on the drawings described in the specification. The tender drawings show the general arrangement of the Engineering Services to be provided and the inter-relationship of the Works with work to be installed by others.

1700 DESIGN DRAWINGS:
Design drawings means drawings prepared, generally to show the details of the design as they are developed from the Tender Drawings.

1800 CO-ORDINATION DRAWINGS:
Co-ordination drawings means drawings, showing the inter-relationship of two or more Engineering Services Systems, and their relation to the structural and architectural details.
The drawings demonstrate that each service can be properly separated from each other and that the services can be satisfactorily installed and maintained.

1900 BUILDER'S WORK, BUILDER'S WORK INFORMATION AND SETTING OUT:
Builder's work is excluded from the Subcontract.
Builder's Work excludes drilling and/or plugging walls, floors, ceilings etc., for fixings for services and such work is included in the Subcontract.
Builders work information means drawings and/or schedules showing requirements for architectural and/or structural provisions necessary to facilitate the Engineering Services Works and allow their integration into the Project.
Such information includes the position and sizes of all access covers, panels and doors required in the building fabric for proper access for and to plant for
installation, maintenance and inspection.
Provide Builder's Work Information, appropriate to the stage of design development, and include requirements for foundations, bases, and supporting structures for plant and equipment.
Provide fully dimensioned drawings showing both size and position of builder's work.
Mark out on site, all cut holes and chases required, any pockets cast in concrete, any inserts, any built in sleeves or similar items.
Holes may not be cut in steelwork, reinforced or precast concrete without written permission from the PM. Under no circumstances will holes be cut in pre-stressed concrete. Permitted holes in steelwork must be drilled - burning by means of welding equipment is prohibited.

2000 INSTALLATION DRAWINGS:
Installation drawings means drawings based on the Tender Drawings showing details of the proposals for the execution of the Works. Ensure such drawings and details relate, where relevant, to Builder's Work information, and to all Architectural, Structural and other drawings.

2200 EQUIPMENT DRAWINGS:
Equipment drawings means drawings detailing principle dimensions, fixings, connections and all other relevant details of an item of equipment. Such drawings are to be specific to the Works and all references to optional features, other equipment of a range, etc. shall be deleted or the original drawing re-drawn to comply with this requirement.
Ensure each drawing
• represents accurately the item concerned with correct dimensions and all connections precisely located.
• Conforms to the specific description given in the Tender Documents, quoting the relevant reference.
• Shows the item in its entirety with no extraneous or alternative parts indicated.

2300 CONTROLS LOGIC DIAGRAMS:
Controls logic diagrams means diagrams, drawings and/or schematic details of all control components and instruments showing the layout with each item uniquely identified together with a description of the controls operation and details of the associated interlocking.
2400 WIRING/CONNECTION DIAGRAMS:
Wiring/connection diagrams means drawings, diagrams or schedules detailing all power and control wiring and control pipework connections between control panels, motors, control components, instruments and any other items requiring electrical connections.
Indicate the following:
- Maximum electrical loading for each supply Cable.
- Cable termination facilities.
- Cable identification and all terminal numbers.

2500 SWITCHGEAR, STARTER AND CONTROL INSTRUMENTATION PANEL DRAWINGS:
Switchgear, starter and control instrument panel drawings means drawings showing the construction and internal wiring diagrams of the starters, panels and/or other devices.

2600 AS-INSTALLED DRAWINGS:
As installed drawings means drawings/records retained on site to record the progress of and any site modifications to the Works including any changes to software.

2700 RECORD DRAWINGS AND SCHEDULES:
Record drawings and schedules means drawings, diagrams and schedules, etc. prepared from as-installed drawings showing the work as finally executed.

2800 PLANT ROOM AND SWITCH ROOM DRAWINGS, SCHEDULES AND SCHEMATICS:
Plant room and switch room drawings, schedules and schematics means drawings, schedules and schematics etc. prepared from as-installed drawings showing the specific information relating to plant and equipment areas.
3000 MANUFACTURERS' REFERENCES:

3100 PERFORMANCE CHARACTERISTIC DETAILS:
Performance characteristic details means details of the equipment as selected for inclusion into the Works and shall include, in a format to be agreed, the following information:

- Plant item description, reference identification and serial number.
- Electrical input rating - kVA, Volts, Phase.
- Operating mode - duty, standby, generator etc.
- Starting characteristics - starter type, current, starts/hour and starting time.
- Performance characteristics - (full load current and power factor).
- Noise level.
- Weight.

3300 INTERPRETATION OF DOCUMENTS:
Drawings expressed in symbolic terms or which are in diagrammatic format, give indicative locations only and details of components are not to be inferred. Arrangements shown on Tender Drawings are intended to indicate layout to be generally adhered to, but actual routes of services are to be such as to ensure the neatest possible arrangement.
Use the wording of the specification in preference to the information provided on the drawings.
Notify the PM of any conflict of information arising from the use of the specification or drawings.

3400 ROOM TERMINAL LOCATIONS:
The positions of all connection points, accessories, apparatus, equipment and other room terminals shown on the tender drawings are approximate and for guidance in the preparation of the tender.
Include for the determination on site, in collaboration with the PM and Contractor, of the finalised position of all such terminals.
Allow for the movement of all such terminals up to a radius of 2.0m from the positions shown on the drawings.
Mounting heights indicated in tender documents are for tender purposes only.
Confirm mounting heights with the PM before commencing work on site.

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3500 EXAMINATION OF DRAWINGS/INFORMATION:
The Bank will examine the propositions submitted for compliance, in principle, with the design intent. Such an examination shall not relieve the originator of such documents of his responsibilities and obligations under the contract.

5000 DOCUMENTS TO BE PROVIDED BY SUBCONTRACTOR

5200 DRAWN AND OTHER INFORMATION:
Provide drawn information for the design team and the Bank in the following forms:-

- Initial copies for comment - Print form
- Final copies for distribution - Print form
- - AutoCad on CD

Provide drawn information for the design team and the bank’s representatives in the following numbers

- Sketch drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Co-ordination drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Builder’s work information - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Installation Drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Shop/fabrication Drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Equipment Drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Control logic Drawings - Initial copies for comment (no) 2
- - Final copies for design team (no) 5
- Control wiring/
Connection Drawings
- Initial copies for comment (no) 2
- Final copies for design team (no) 5

- Switchgear, Starter and control instrumentation panel drawings
  - Initial copies for comment (no) 2
  - Final copies for design team (no) 5

- As-installed drawings
  - Site Record copy

- Record Drawings
  - Initial copies for comment (no) 2
  - 2 Preliminary sets for use during commissioning.
  - 1 CD soft copy for the Bank’s use
  - 1 Set for the Bank’s use.
  - 1 reduced set incorporated in each Operating and Maintenance manual.

- Plantroom Schedules and Schematics
  - Initial copies for comment (no) 2
  - Initial copies for comment (no) 2
  - 2 Preliminary sets for use during commissioning.
  - 1 Framed set for plantroom
  - 1 Set for the Bank’s use.
  - 1 reduced set incorporated in each Operating and Maintenance manual.

Provide drawings for construction in form and number as required by the Contractor.

5300 PREPARATION OF DOCUMENTS:
Prepare drawings to commonly recognized scales generally on A1 or A2 sheets and details and schedules on A3 sheets. Agree scales, drawing sheet size and format with the PM before preparing any documents.

5400 SYMBOLS:
Ensure the notation on documents produced follows the same conventions as the tender documentation.

AfDB: Electrical Specifications
Agree any additional notation to be used with the PM before preparing any documents.

5500 DOCUMENT NUMBERING/REGISTRATION SYSTEM:
Agree with the Bank the document numbering/registration system to be used before preparing any documents.

5600 BUILDER’S WORK INFORMATION:
Confirm and amplify any builder's work information provided by the Bank.

5700 SUBMISSION OF RECORD DOCUMENTS:
To satisfy the provisions of the Health and Safety at Work Act the Bank will not accept handover of the installations until full and adequate information concerning the installations is in the possession of his operating and maintenance staff.

- Provide Record Documents - being part of the Works - prior, and as a prerequisite, to Practical Completion to the satisfaction of the Bank.
- Prepare manuals in draft as the Works progress and make suitable arrangements where the Works are subject to Partial Possession or Sectional Completion.
- Submit draft Record Documents to the Bank for comment prior to commissioning.
- Prepare two temporary Manuals with provisional record drawings and preliminary performance data available at commencement of commissioning to enable the Bank's staff to familiarize themselves with the installation. These should be of the same format as the final Manuals with temporary insertions for items which Cannot be finalized until the installations are commissioned and performance tested.
- Provide the Bank with copies of the final Manual not more than 2 weeks prior to Practical Completion.

5800 RECORD DOCUMENTS:
Provide
- Record Drawings and Schedules.
- Plant room and switch room drawings, schedules and schematics.
- Operating and Maintenance Manuals.

Ensure Record Documents
- Clearly record the arrangements of the various sections of the Works as
actually installed and identify and locate all component parts.

- Make it possible to comprehend the extent and purpose of the Works and the method of operation thereof.
- Set out the extent to which maintenance and servicing is required and how, in detail, it should be executed.
- Provide sufficient, readily accessible and proper information to enable spares and replacements to be ordered.
- Correlate record documents so that the terminology and the references used are consistent with those used in the physical identification of the component parts of the installations.
- Demonstrate as required throughout the execution of the Works that complete and accurate records are being maintained and that the record documents are being progressively compiled as the work on site proceeds.

5900 RECORD DRAWINGS AND SCHEDULES:

Prepare Record Drawings and Schedules from the "As Installed Drawings" maintained on site as the Works progress. Endorse all such documents "RECORD DRAWINGS". Where agreed with the Bank certain detailed information may be provide in schedule form. Provide reduced scale copies for inclusion in the operating and maintenance manuals as detailed in clause A31.6100. Record Drawings and Schedules must include, but are not limited to

- Location, including level if buried, of Utility Service connections, including those provided by the appropriate Authority, indicating points of origin and termination, size and material of service, pressure and/or other relevant information.
- Disposition and depth of all underground systems.
- Schematic drawings of each system indicating principal items of plant, equipment, zoning, means of isolation, etc. in sufficient detail to make it possible to comprehend the system operation and the inter-connections between various systems.
- Details of the principles of application of automatic controls and instrumentation.
- Diagrammatic dimensioned plans and sections of each system or service showing sizes and locations of all ancillaries, plant, equipment controls, test points, and means of isolation etc. including any items forming an integral part of the engineering systems provided by others (such as plenum ceilings, builders' work shafts, chimneys etc.).
- Identification of all terminals/Cables etc. by size/type and duty/rating as
recorded from the approved commissioning results.

- Detailed wiring drawings/diagrams/schedules for all systems, including controls, showing origin, route, Cable/conduit size, type, number of conductors, length, termination size and identification, and measured conductor and earth continuity resistance of each circuit. Ensure routes. Indicate if Cable/conduit is surface mounted, concealed in wall chase, in floor screed, Cast in-situ, above false ceiling etc.

- Details of co-ordination of wiring and connections with Cable core identification, notation of fire alarm, security, control and instrumentation and similar systems provided as part of the Works.

- Details to show inter-connections between the Works and equipment or systems provided by others to which wiring and connections are Carried out as part of the Works.

- Location and identity of each room or space housing plant, machinery or apparatus.

- Dimensioned plans and sections of plant rooms, service subways, trenches, ducts and other congested areas where in the opinion of the PM smaller scale drawings Cannot provide an adequate record. Indicate the Location, identity, size and details of each piece of apparatus.

Manufacturers' drawings of equipment indicating

- general arrangement and assembly of component parts which may require servicing.

- internal wiring diagrams together with sufficient physical arrangement details to locate and identify component parts.

- schedules as required to locate, reference and provide details of ratings and duty of all items incorporated into the Works together with all fixed and variable equipment settings established during commissioning.

**6000 PLANT ROOM AND SWITCH ROOM DRAWINGS, SCHEDULES AND SCHEMATICS:**

Provide good quality plant and switch room drawings schedules and schematics. Hang the following in each plant room and switch room, any other appropriate Location or where directed by the Bank.

- Schematic drawings of circuit layouts showing identification and duties of equipment, numbers and locations, controls and circuits.

- Schedules in the form of printed sheets showing the number, type, Location, application/service and symbol, and normal operating position of each means of isolation.

- Control schematics.

- Location of all plant and equipment items including plans and elevations of
main switchgear showing physical disposition of switches.

• All other items required under Statutory or other regulations.
• Location of all incoming service isolating and metering facilities.
• Emergency operating procedures and telephone numbers for emergency call out service applicable to any system or item of plant and equipment.
• Protect surface of drawings by pressure lamination

6100 OPERATING AND MAINTENANCE MANUALS:
Provide operating and maintenance manuals. Agree format and contents with the Bank, but all O & M document must also be available in electronic format using an approved Word processor or Desk Top Publishing Software.
Operating and maintenance manuals must include, but are not limited to the following:

• Index of contents.
• A full description of each of the systems installed, written to ensure that the Bank’s staff fully understand the scope and facilities provided. Description to include data on general design parameters, normal associated operating conditions and manufacturers information concerning correct operation, etc. based on commissioning results.
• A description of the mode of operation of all systems.
• Diagrammatic drawings of each system indicating principal items of plant, equipment, valves etc.
• A photo-reduction of all record drawings, together with an index. Size A3
• Legend for all colour-coded services.
• Schedules (system by system) of plant, equipment, valves, etc., stating their locations within the building, duties and performance figures. Ensure each item has a unique code number cross-referenced to the record and diagrammatic drawings and schedules.
• The name, address and telephone number of the manufacturer of every item of plant and equipment together with Catalogue list and order acknowledgement numbers.
• Manufacturer’s technical literature for all items of plant and equipment, assembled specifically for the project, excluding irrelevant matter and including detailed drawings, electrical circuit details and operating and maintenance instructions.
• A copy of all Test Certificates, Inspection and Test Records, Commissioning and Performance Test Records (including, but not limited to, electrical circuit tests, corrosion tests, type tests, start and commissioning tests) for the installations and plant, equipment, valves, etc.,
used in the installations.

- A copy of all manufacturers' guarantees or warranties.
- Copies of Insurance & Inspecting Authority Certificates and Reports.
- Starting up, operating and shutting down instructions for all equipment and systems installed.
- Details of procedures to maintain plant in safe working conditions.
- Control sequences for all systems installed.
- Details of regular tests to be Carried out (e.g. water cooling towers etc.)
- Copies of relevant HSE/CIBSE/IEE Guidance notes etc.
- Procedures for seasonal change-overs and/or precautions necessary for the Care of apparatus subject to seasonal disuse.
- Recommendations for the preventative maintenance frequency and procedures which should be adopted by the Bank to ensure the most efficient operation of the systems.
- Details of lubrication systems and lubrication schedules for all lubricated items.
- A list of normal consumable items.
- A list of recommended spares to be kept in stock by the Bank, being those items subject to wear or deterioration and which may involve the Bank in extended deliveries when replacements are required at some future date.
- A list of any special tools needed for maintenance cross referenced to the particular item for which required.
- Procedures for fault finding.
- Emergency procedures, including telephone numbers for emergency services.
- Copies of all items incorporated in the Plant room and switch room schedules and schematics.

6300 TECHNICAL LITERATURE:
The Subcontractor is required to keep copies of the following on site, readily accessible for reference by all supervisory personnel

- Manufacturer's current literature relating to all products to be used in the Works.
- Relevant BS Codes of Practice.

6400 MAINTENANCE INSTRUCTIONS AND GUARANTEES:
Retain copies delivered with components and equipment (failing which, obtain), register with manufacturer as necessary and hand over to the Bank on or before Practical Completion.
Notify the Bank of telephone numbers for emergency services by Subcontractors.
after Practical completion.

**BS APPENDIX**

BS 7671:2008
Requirements for electrical installations. IEE Wiring Regulations. Seventeenth edition

BS EN 61082-1:2006
Preparation of documents used in electrotechnology. Part 1 General requirements

BS EN 61082-2:1994
Preparation of documents used in electrotechnology. Part 2 Function-oriented diagrams

BS EN 61082-3:1994
Preparation of documents used in electrotechnology. Part 3 Connection diagrams, tables and lists

BS EN 61082-4:1996
Preparation of documents used in electrotechnology. Part 4 Location and installation documents

BS EN ISO 11091:1999
Construction drawings. Landscape drawing practice

BS EN ISO 13567-1:2002
Technical product documentation. Organization and naming of layers for CAD. Part 1 Overview and principles

BS EN ISO 13567-2:2002
Technical product documentation. Organization and naming of layers for CAD. Part 2 Concepts, format and codes used in construction documentation

BS EN ISO 3766:2003
Construction drawings. Simplified representation of concrete reinforcement

BS EN ISO 7518:1999
Construction drawings. Simplified representation of demolition and rebuilding
A32 MANAGEMENT OF THE WORKS

1100 MAIN CONTRACT PRELIMINARIES:
Section A32 - Management of the Works applies to the whole of the Works, including this Subcontract. Comply with the requirements specified therein in so far as they apply to the Subcontract Works, and co-operate with and assist the Main Contractor in complying with them generally.

1200 CO-OPERATE:
Co-operate with the Contractor, other subcontractors, suppliers, local authorities and statutory undertakings in the execution of their work.

1300 PROGRAMME/PROGRESS:
Provide detailed sub-programmes to assist the Contractor in producing a Master Programme for the Contract Works.
Due allowance is to be made in the programme(s) for the Works for, but not limited to, the following:
- Ordering and installation periods.
- The completion of drawing, etc. and the minimum of working days for comment.
- Work resulting from instructions issued in respect to the expenditure of provisional sums.
- Concurrent work by other trades.
- Any temporary works necessary for the completion of the engineering services installations.
- Pre-commissioning, commissioning and performance testing of the engineering services installations.
- Preparation and provision of Record Drawings and Operating and Maintenance Manuals.
- Provide programme information as simple bar chart type.

1400 MONITORING:
Record progress of the Works weekly on a copy of the programme kept on site. Update or redraft programme without delay if any circumstances arise which affect the progress of the Works. Mark up "As Installed" details weekly and before any work is hidden from view.
1500 INSPECTION AND MEASUREMENT OF WORK:

Provide all necessary assistance to enable PM to examine or measure the Works.

1600 COVERING-UP:
Ensure no section of the Works are covered, concealed or insulated until completion of a witnessed satisfactory test.
Give not less than 3 working day(s) notice when works which are to be covered or concealed are ready for examination and/or measurement.
Give notice to (Services) Engineering.
A33 QUALITY STANDARDS/CONTROL

1100 MAIN CONTRACT PRELIMINARIES:
Section A33 - Quality Standards/control applies to the whole of the Works, including this Subcontract. Comply with the requirements stated therein in so far as they relate or apply to the Subcontract Works, and co-operate with and assist the Main Contractor in complying with them generally.

1300 SUBCONTRACTOR'S PERSON-IN-CHARGE:
Appoint a foreman - in charge and/or site agent to ensure constant management and supervision of the Subcontract Works. Give maximum possible notice to the Contractor and the Bank before changing the foreman – in - charge or site agent.

1400 DIMENSIONS:
Where installations are dependent upon site dimensions ensure that these are available before proceeding with the Works. Do not take dimensions by scaling from the drawings. Where dimensions are indicated on drawings check these on site, as appropriate, to ensure building construction and manufacturing tolerances can be accommodated.

1500 SETTING OUT FOR THE SUBCONTRACT WORK:
Where this is done by the Main Contractor check its accuracy and obtain his approval before proceeding with the work.

1600 SITE MODIFICATIONS:
Do not make site modifications to assemblies without authorization. Where site modifications to assemblies are authorized make in accordance with manufacturer's certified drawings and instructions. Ensure that modifications made comply with any type test certificate obtained for arrangement of components.

1700 STANDARDS AND REGULATIONS:
Provide all materials and works in accordance with the appropriate British Standard or Code of Practice and LEED reference guide for green building design and construction 2009 EDITION and where no BS or CP is applicable the Agreement Certificate for the particular item is to be provided. Comply with all statutory instruments and regulations including LEED, and local byelaws relating to the area of the site current at the date of tender or at the time of executing the works. Comply with the requirements of the Local Authority Building Inspector. Comply with all relevant requirements included in the Main Contract Preliminaries Section A20 regarding Statutory Obligations.
Notify all authorities in accordance with their regulations and obtain any required approvals for the installation. Where no specific design, performance or installation standards are quoted the following shall apply:

- C.I.B.S.E Codes of Practice.
- Institute of Plumbing Data Handbook.
- C.I.B.S.E Code for Interior Lighting.
- C.I.B.S.E Technical Reports.
- C.I.B.S.E Technical Memoranda.

Ensure all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed at the same location. Supply plant and equipment to achieve the specified design conditions and to provide stable control.

1900 SUITABILITY OF MATERIALS AND PRODUCTS:

Use materials and products which

- are new unless specified otherwise.
- are suitable for the services and conditions of use normally expected to apply after the installation is complete.
- are able to withstand the testing and commissioning conditions specified.
- do not initiate mould growth, support vermin, contain animal hair, contain crocidolite or support bacterial life.
- do not involve the use of CFC's at any stage of manufacture, installation or subsequent operation except where specified.
- are free from objectionable odors at the maximum or normal working conditions of operation.
- do not suffer deterioration at the maximum or specified conditions of operation.
- are Capable of being applied to a base surface without causing damage or deterioration of the base.
- are not a fire hazard, and do not evolve dense or toxic fumes when subjected to excessive heat, such as a fire.

When of similar type, are made by the same manufacturer. Whenever possible ensure products are manufactured and/or stocked under one of the following:

- BSI Kitemark Scheme.
- BSI Safety Mark Scheme.
- from Firms of Assessed Capability to BS EN ISO 9000.
- from Stockists of Assessed Capability to BS EN ISO 9000.

No materials generally known to be deleterious are to be used in, or incorporated into, any temporary or permanent part of the Works.
In particular use none of the following:-
Asbestos products.
Urea formaldehyde.
Check with manufacturers and/or suppliers of products and materials that products contain no such deleterious materials. If any specified product contains such material request an alternative specification of product, manufacturer or supplier.

2000 SAMPLES:
Submit samples detailed in Work Sections to the PM. Retain on site until the completion of the contract.

2100 TYPE TESTS:
Provide certificates of verification of type tests. Ensure that drawings and other documents forming part of certificate are available prior to any order being placed.

2200 TEST CERTIFICATES:
Where testing specific to the project is required, ensure test certificates includes:
- Project title.
- Details and date of test.
- Instruments used, serial numbers, calibration dates.
- Signature of those witnessing test.
- Contractor’s name.
- Specific location of the item in the Works.

2300 INSPECTION AND TESTS - ON OR OFF-SITE:
Submit schedules showing those parts of the Works for which inspections and tests are required in the specifications, to substantiate conformity with the Specification and for which records are required to be maintained. Should any alternative item be proposed which does not carry appropriate certification, ensure independent testing is carried out at no expense to the Bank to confirm compliance.
Where required, provide formal method statements supported by risk assessments detailing the procedures for carrying-out on site tests. Agree in advance with all parties procedures for inspections and tests including periods of notice.
Where a test indicates non-compliance with the Specification submit immediately details of the non-compliance and proposals for corrective action.
Arrange access for personnel who require to be in attendance, to manufacturer’s or other off site premises when any inspections and tests carried out.
Attendance or otherwise of the supervisory personnel during specified inspections or tests will not reduce the obligations or restrictions of the Contract.

carry out all tests required by legislation under the direction of a "competent person".

2400 INSPECTIONS AND TEST RECORDS:
Prepare a set of drawings and/or report sheets to record accurately the test and inspection information including the following:
- Plant identification, section and installation under test.
- Manufacturer's reference number.
- Date, time, duration of test, weather conditions.
- Test results with itemised readings including records of all other checks and tests.

Maintain records of all specified inspections and tests performed including third party and works test certificates.

Include in records, as appropriate, details of the element, item, batch or lot, the nature, number and date of the inspections and tests, the number and type of deficiencies found, any corrective action taken and other relevant particulars.

Maintain all records on site for inspection. On completion of the Works, include copies in the operating and maintenance manuals.
Submit copies of records within one week of request.

2500 TESTING AND COMMISSIONING OF SERVICES:
Agree with the Contractor a programme for pre-commissioning checks, setting to work, commissioning and performance testing, and allow for all costs incurred.

Where required, provide formal method statements supported by risk assessments detailing all commissioning procedures.

Give not less than fourteen working days notice to the Contractor and the Bank and state any requirements for the attendance and co-operation of others.

Provide all necessary facilities to enable tests to be witnessed and inspections carried out either on site or at manufacturer's works.

The Bank will only witness test proceedings, confirm recorded results and determine if the specified requirements have been satisfied. If following test or inspection any plant or part thereof is shown to be defective or not conforming to the specification the Bank will reject such defective parts by written notice, within reasonable time, indicating area of dispute.

Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities.

Test all equipment, material and systems as detailed in Work Sections. If an inspection or test fails, repeat the procedure, until satisfactory results are obtained.
Complete all tests before any paint, cladding or similar materials are applied or before services are concealed. Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning. Following satisfactory completion of testing and when the installations are in a safe and satisfactory condition, set to work, regulate and adjust, as necessary, to meet the specified design requirements. Provide all necessary instruments and recorders to monitor systems during commissioning and performance testing. Do not start performance testing, including system demonstration, system proving or environmental and capacity testing, until commissioning of the system is completed to the satisfaction of the Bank. Maintain on site full records of all commissioning and performance testing, cross referenced to system components and on completion of the Works include a copy in each Operating and Maintenance Manual. Provide all certification documents for approval by the Bank before any system is offered for final acceptance.

2600 COMMISSIONING PROCEDURES:
Observing the following requirements when commissioning the Engineering Services. The commissioning process shall be coordinated with the commissioning authority requirements according to LEED. Progressive static testing will be witnessed by the commissioning authority when work is presented for testing. This will include but not limited to the following:
- Insulation resistance tests.
- Earth fault loop impedance tests.
- Earth continuity tests.
Pre-commissioning examination and testing to ensure that each system or item of equipment is complete, in a safe condition and all notices are displayed. "Completion" for operational purposes implies the bulk of snagging has been offered to the Bank and that remedial work has been completed. All fans, pumps etc. tested for operation, polarity, phase sequence and impedance etc. Finalise commissioning programme, taking into account site progress and availability of related services, with the Bank and Contractor and agree access required for controls etc.

2800 OUTSTANDING ACCEPTANCE TESTS:
Any items which have failed their acceptance tests or where such tests are delayed by the Bank are to be listed and dates agreed, during the defects liability period when reasonable demands for consumer requirements are available.
3000  OPERATION OF SYSTEMS BEFORE THE PRODUCTION OF RECORD DRAWINGS AND/OR OPERATING AND MAINTENANCE MANUALS:
Provide attendance, at no expense to the Bank, to put into service, operate 24 hours a day and maintain the systems to the Bank's requirements, including the provision of suitable competent labour, in the event that the Record Drawings and/or Maintenance Manuals are not available when the Works would, in the opinion of the Bank, otherwise qualify for Practical Completion. In the event of the Subcontractor failing to provide this service satisfactorily the Bank shall be entitled to make his own arrangements and recover the full cost through the Contract.

3100  INSPECTION BY BANK'S INSURANCE COMPANY:
Where indicated in the Work Sections items are to be inspected by a "competent person" acting for the Bank's Insurance Company appointed under the provisions of the Factories Act or other relevant legislation. The installations concerned shall satisfy the Insurance Company's requirements in all respects.
Agree a programme for inspection and certification of specified equipment.
Inform the PM when equipment is to be ready for examination.
The Bank will place an order with the Insurance Company. Details and nature of the order will be provided to all interested parties.
Provide all detailed drawings etc. of the equipment to enable the Insurance Company to approve design before manufacture.
Arrange for the attendance of the Insurance Company's Engineer/Surveyor at each stage of manufacture and installation and provide all necessary access and facilities for inspecting and testing as may be required.
No plant which is subject to "inspection" will be accepted on behalf of the Bank until a satisfactory certificate has been received by the Bank from the Insurance Company.
All Insurance Company charges for examination and approval of drawing, inspection of works during construction and inspection and certification of the completed work will be paid by The Bank.
A34 SECURITY/SAFETY/PROTECTION

1100 MAIN CONTRACT PRELIMINARIES:
Section A34 - Security/safety/protection applies to the whole of the Works, including this Subcontract. Comply with the requirements stated therein in so far as they relate or apply to the Subcontract Works, and co-operate with and assist the Main Contractor in complying with them generally.

1150 CDM REGULATIONS:
Comply with the requirements of the CDM Regulations by
- adhering to the rules of the Health and Safety Plan.
- reporting accidents, injuries or dangerous occurrences to the main contractor.
- providing the main contractor with appropriate input to the health and safety plan, including risk assessments, and to the health and safety file.
- providing the main contractor with information on the subcontract works which might affect the health or safety of any person.

1200 DELIVERY:
Provide adequate and safe protection for all materials and products during transport to site.
Deliver all ductwork, tubes, conduit, trunking and associated equipment with open ends effectively plugged, capped or sealed.

1300 HANDLING:
Offload and transport about the Works all materials and products as recommended by manufacturers.

1400 STORAGE:
Store all materials and products as recommended by manufacturers. Provide sufficient, safe and secure storage for all materials and products.
Provide racks to prevent distortion for storage of conduits, pipes and similar materials.
Store all fittings, accessories and sundry items in clean bins or bagged and stowed in racks and maintained under suitable weatherproof cover.
PROTECTION OF SUBCONTRACT WORKS:
Provide adequate and safe protection for all materials and products after installation.
Ensure all items are protected against ingress of water and dust, formation of condensation, extremes and rapid changes of temperature, building works and operations of others.
Protect during erection all easily damaged materials with hardboard covers or heavy duty polythene sheet. Such items include but are not limited to
- control panels,
- switchboards,
- distribution boards,
- finned pipework,
- gauge glasses,
Protect all finished items from damage and paint splashes. Install items such as lighting fittings, switches accessories etc. as near to completion as practicable.
Cover all plant items with polythene sheeting except when being worked upon.
Cap all open ends of pipes, ducts, conduit and trunking etc except when being worked upon.
Leave plant and equipment in a ready to paint condition where specified as part of the Works or to be carried out by others.
Paint parts liable to corrosion immediately after removal of any temporary protection.
Replace material, plant or equipment where deterioration or damage has occurred prior to handover.

IDENTIFICATION:
Where appropriate, ensure that materials, plant and equipment bear the brand name, serial/batch number and any other data required to identify their nature in relation to the Works.

ROTATING PLANT:
Immediately prior to Practical Completion adjust, grease and lubricate moving parts as necessary to ensure easy and efficient operation.
Ensure that, whenever necessary, temporary supplies are provided to enable motive plant items delivered and/or installed to be run at regular intervals to avoid damage or deterioration.
Ensure that rotating plant is hand-turned periodically if temporary supplies are not available.
A35 SPECIFIC LIMITATIONS ON METHOD/SEQUENCE/TIMING

1100 MAIN CONTRACT PRELIMINARIES:
Section A35 - Specific limitations on method/sequence/timing applies to the whole of the Works, including this Subcontract. Work within the limitations stated therein in so far as they relate or apply to the Subcontract Works, and co-operate with and assist the Main Contractor in working within them generally.

1200 SPECIFIC LIMITATIONS:
Method/sequence of work.
- Work method/sequence laid out in the various Work Sections shall be agreed with the PM and the Bank.

Working area.
- Due to confined nature of the work site, it is expected that the Sub-Contractor will need to properly schedule the bringing of materials to site so as not to Cause a hinderance or nuisance to other trades, neighbours or the Bank. Adequate storage may need to be provided at the Sub-Contractor's yard.

Working hours.
- Some aspect of the works may have to be Carried out over the weekend or outside the Bank's normal working hours.

1300 ORDERING OF MATERIALS AND PRODUCTS:
Ensure that procurement details of materials are incorporated in the Subcontract programme.
Order all materials/products necessary for the completion of the Works immediately after receipt of comments received and/or instructions to proceed. No delay to Practical completion, or completion of any part there of caused by delays in ordering will be accepted.
A37 OPERATION/MAINTENANCE OF THE FINISHED BUILDING

1100 RECOMMENDED SPARE PARTS:
At least 12 weeks before Practical Completion submit to the Bank a schedule of spare parts as called for in individual Work Sections and any others that the Subcontractor recommends should be obtained and kept in stock by the Bank for maintenance of the services installations included in the Subcontract.
State against each item the manufacturer's current price, including packaging and delivery to site.
Identify those items which are additional to those specified for inclusion in individual Work Sections.

1200 INITIAL SUPPLY OF ADDITIONAL SPARE PARTS:
Within 4 weeks of request submit to the PM a quotation, priced in detail, for the initial supply to the Bank of the additional spare parts identified under clause A37.1100, and including for:
- Checking that each spare part is suitable for the replacement of the corresponding part supplied with the item of plant or equipment.
- Checking receipt, marking and numbering in accordance with the schedule of spare parts.
- Referencing to the plant and equipment list in the Operation and Maintenance Manual.
- Painting, greasing, etc. and packing to prevent deterioration during storage.

1300 RECOMMENDED TOOLS:
At least 10 weeks before Practical Completion submit to the Bank a schedule of tools and portable instruments as called for in individual Work Sections and any others that the Subcontractor recommends should be obtained and kept in stock by the Bank for maintenance of the services installations included in the Subcontract.
State against each item the manufacturer's current price, including packaging and delivery to site.
Identify those items which are additional to those specified for inclusion in individual Work Sections.
1400 SUPPLY OF TOOLS:
Provide all tools detailed within individual Work Sections. On request submit to the Bank a quotation, priced in detail, for the initial supply to the Bank of the additional tools identified under clause A37.1300, and including for the following.

1500 TRAINING OF BANK’S STAFF:
Before Practical Completion, explain and demonstrate to the Bank’s maintenance staff the purpose, function and operation of the installations including all items and procedures listed in the Operation and Maintenance Manual.
Include for not less than 28 operating days per staff member for this purpose and demonstrate the safe, day to day running and maintenance of all systems, plant and equipment.
The training program shall be detailed such that it can be repeated for new and replacement personnel.
Thorough documentation must be supplied for future training activities.
The training program shall furnish a thorough understanding of all equipment, components, systems, and their operation, including appropriate how-to skills. Certifications of attendance to be given in each training session, and training sessions should be videotaped.
Provide training for the operation of the controls, monitoring or BMS installations as follows.
- Carry out initial training at the controls suppliers works.
- Include "hands on" experience of equipment and software similar to the installation.
- Include instruction on the procedures for testing and routine inspection of sensors and actuators to enable the operator to assess the nature of faults and extent of remedial action required.
- Provide all appropriate reference and training manuals.
- Complete initial instruction prior to commissioning the installed system.
- Provide site instruction on the installed system, including not less than 28 operating days per staff member for this purpose.

1600 READING OF METERS:
Record readings of all water, gas, and electricity meters immediately on completion of the Works and forward, via the Main Contractor, to the Bank.

1700 OBLIGATIONS DURING DEFECTS LIABILITY PERIOD:
Prepare and submit records of failures or malfunctions of any part of the Subcontract Works during the Defects Liability Period, together with details of remedial action taken, subsequent re-testing and the results.
Notify the Main Contractor of damage, failures or malfunctions to the Subcontract Works demonstrably caused by incorrect operation of the installations, vandalism or other actions by a third party. Inform the Bank, via the Main Contractor, in writing when all defects are finally rectified so that an inspection may be carried out prior to the issue of a Final Certificate.
1100 COMMISSIONING DEFINITIONS

**COMMISSIONING:** the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent. In this guideline, commissioning begins with planning and includes design, construction, start-up, acceptance and training, and can be applied throughout the life of the building.

**COMMISSIONING AUTHORITY:** the designated person, company, or agent who implements the commissioning according to LEED requirements.

**COMMISSIONING PLAN:** a document defining the commissioning process, which is developed in increasing detail as the project progresses through its various phases.

**COMMISSIONING TEAM:** those people responsible for working together in carrying out the commissioning process.

**SYSTEMS MANUAL:** a composite document that expands the scope of the operation manual and maintenance manual developed in ASHRAE Guideline 4-1993 by including the additional information gathered by the commissioning process.

**VERIFICATION:** that full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems operate in accordance with the contract documents. In this context, “operate” includes all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

1200 COMMISSIONING MANAGEMENT

Ensure that regularly scheduled meetings of the entire commissioning team are held for the purpose of site coordination.

Provide the commissioning authority with a copy (hard and soft) of all material submittals, shop drawing revisions, operation and maintenance documentations and systems manual.

Ensure that commissioning plan is being followed by all concerned subcontractors and that a copy of all test forms is being delivered to the commissioning authority.
1300 COMMISSIONING PLAN

The contractor should follow the commissioning plan and procedures on site and also action the following:

- Submit a copy of the following:
  - all shop drawing revisions,
  - operation and maintenance documents,
  - system manuals,
  - on-site testing forms signed by all concerned parties,
  - technical data for all equipment and material submittals etc.

- Invite the commissioning team whenever required on site.

- Attend regular commissioning meetings as per commissioning plan requirements.

- Provide videotaped training sessions at the end of the project for operations personnel (Certificate of attendance is to be given, and some trainings will have to be verified by the commissioning authority).

- The contractor shall provide all necessary testing equipment, and shall conduct tests under the supervision of the commissioning authority; these tests or part of the tests will be repeated after 10 months of practical completion in order to review the building’s operation and maintenance after final acceptance.

1400 COMMISSIONING REQUIREMENTS

The subcontractor shall provide all necessary testing equipment and teams in order to undertake all tests of acceptance and to follow the commissioning plan.

The subcontractor shall be available for the warranty review site visit and shall make all necessary tests (required by the commissioning authority) for the verification of the system operation.
V10 ELECTRICITY GENERATION PLANT

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES

The estimated demand load for the development is about 550KVA

Three(3) soundproof generator sets (2duty/1standby) each rated at 325kVA, 400V, 50Hz will be provided to serve the premises. The set will have an automatic mains failure panel and required to start and run when the primary supply is lost.

All requirements shall be rated for "standby power".

The generator sound-proof cabin which shall be constructed from non-carcinogenic noise reduction materials, shall be required to meet with internationally accepted standards in noise reduction level. Further to this, noise levels of 75dBA at 1m and 65dBA at 10m are the maximum acceptable noise levels.

Further to this, noise levels of 75dBA at 1m and 65dBA at 10m are the maximum acceptable noise levels.

1030 SYSTEM DESCRIPTION

Diesel power generating sets rated for 100% of the load requirement shall be provided.

Further to this, 3No. Generators each rated at 325kVA, 400V, 50Hz shall be provided.

This allows for almost 50% redundancy in the standby power installation.

In the event that one of the sets is down for repairs or maintenance, the standby generator are able to meet 100% of the demand load.

The generators shall be installed in an enclosure in the service yard. The mountings shall also be appropriately isolated.

Engine exhaust from the generator shall be taken to at least 1 meter above the highest point of the generator house.
An auto mains failure (AMF) control panel and synchronization panel integral to the main LV panel shall be provided for the generators. The synchronizing panel shall include for an automatic load sharing feature as well as the selection of the duty units. The system shall have a digital based control system.

The system is normally run from the utility power.

In the event of the primary supply failure, all the standby generator shall automatically start and run and synchronize and upon achieving rated voltage and frequency pick load.

On restoration of the mains supply, the loads are transferred back after a pre-set time delay. The generators are shut-down after a pre-set run-down period.

The selection of the duty generators can be achieved manually or automatically. The selection can be based on hours run (or any other criteria that can be agreed upon).

The sets shall be the single engine driven type and shall have nominal electric characteristics as indicated and shall be able to supply the indicated kW load at power factors down to 80 per cent.

Load handling of the plant to be such as to permit the specified load to be carried continuously without trouble or damage.

Voltage regulation to be such as to permit a setting of the manual voltage adjustment device which will maintain the output voltage within a range of +/- 2% of the nominal for any steady state load from no load up to the specified load conditions.

Stable operation to be such that for any particular steady state (between no-load and the specified load conditions) the steady state frequency deviation shall not exceed $\frac{1}{3}$%.

Stable operation to be such that for any particular steady state (between no-load and the specified load conditions) the steady state voltage deviation shall not exceed $\frac{1}{2}$%.

Surge handling Capability to be such that no combination of the steady and surging "KW" loads, or surging "KW" alone, whose overall value is within 100% of the figure specified for the sustained "KW" load to be supplied, shall Cause the
machine to stall.

Surge handling Capability to be such that no combination of steady and surging "KVA" loads, or surging "KVA" alone, whose overall value is within 100% of the figure specified and whose related "KW" component is within the limit stated above, shall cause an output voltage fluctuation in the excess of 40% of the nominal.

Surge handling Capability to be such that stable operation as specified above is re-established within 3 seconds after any surge.

Start up Capability to be such that rated voltage and frequency is obtained 10 seconds following the closing of the contact in the external cranking circuit.

In the event of mains power failure, the 2 duty sets shall start. If one of the duty sets fails to start after a pre-set number of attempts, the standby set will start.

**1040 CONTROL REQUIREMENTS**

The system is required to be fully automatic as stated.
Interlock facilities are provided between the supplies to prevent accidental parallel operation.
Automatic Mains Failure start/stop
Load Sharing between the active sets.
Manual override for all auto functions.
PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2450 SILENCERS/ACOUSTIC TREATMENT

2451 SILENCERS/ACOUSTIC TREATMENT GENERALLY:
Comply with work section Y45 General clauses and those detailed below.

2453 SOUND POWER LEVELS:
Provide equipment to achieve sound power levels specified in System Objectives.

245L WORKMANSHIP
General - reference Y45.3010
Acoustic enclosures - reference Y45.3020
Access to acoustic enclosures - reference Y45.3030
Supports - reference Y45.3040
Acoustic linings - reference Y45.3050
Sound power level readings - reference Y45.3060
Measure sound insulation of building elements
Reference Y45.3070

2500 THERMAL INSULATION

2501 THERMAL INSULATION GENERALLY:
Comply with work section Y50 General clauses and those detailed below.

2520 VIBRATION ISOLATION MOUNTINGS

2521 VIBRATION ISOLATION MOUNTINGS GENERALLY:
Comply with work section Y52 General clauses and those detailed below.

2523 PLANT AND PIPEWORK VIBRATION ISOLATION SCHEDULE:
As schedule reference

252N WORKMANSHIP
General - reference Y52.3010
Cast in situ bases - reference Y52.3020
Fixing - reference Y52.3030
Horizontally restrained spring mountings
Reference Y52.3040
2800  EARTHING AND BONDING COMPONENTS

2801  EARTHING AND BONDING COMPONENTS:
Comply with work section Y80 general clauses and those detailed below.

2803  EARTHING AND BONDING COMPONENTS SPECIFICATION:
Supply earthing and bonding components as specified in section

2805T  CONDUCTORS:
Type: Bare copper Cable.

Conductors for earthing systems to BS 7430.
Reference Y80.2010C
Conductor joints
Reference Y80.2020A

2807T  EARTH ELECTRODES:

Earth electrodes for system earthing.
Reference Y80.2040B
Earth electrode clamps - reference Y80.2060
PART 3 SPECIFICATION CLAUSES SPECIFIC TO V10.

3000 GENERAL

3010T GENERATING SET APPLICATION RATING AND PERFORMANCE:
Provide alternating current generating set driven by a reciprocating internal combustion engine in accordance with BS 7698, with characteristics:
Prime mover.
Compression-ignition.
Diesel.
Generated electricity supply.
3 phase 4 wire ac.
400 Volts 50 Hz.
Generator.
Synchronous.
Mode of operation.
Standby operation.

Site criteria.
Land use.
Operation.
Single.
Modes of start-up and control.
Auto/Manual
Start-up time.
Short break set.
Power available in time (seconds) : 15
Installation features.
Fixed.
Self contained package.
Mounting type.
Rigid.
Power rating (kW) : as indicated on the drawings.
Rated frequency (Hz) : 50
Power factor.
0.8 lagging
Kinds of power output.
Continuous power.
Prime power.
3020 GUARDS:
Guard all exposed hot or moving parts in accordance with BS 5304 and Health and Safety at Work Act, 1974.
4000 PRODUCTS/MATERIALS

4010T GENERATOR SET:
Application
  Mains standby and as specified in the bill of quantities and schematic drawing.
Provide generating set to BS 7698.
  Load characteristics for generating set sizing.
    Power requirements of connected load: as shown on the load schedule.
    Diversity factor of connected load: as specified in the schedule of loads drawing.
  Power factor: 80 per cent.

4030T ENGINE:
Provide engine for generating set in accordance with BS 7698 and BS 5514.
  Engine type.
    Naturally aspirated.
    Water cooled.
    Compression ignition.
    Diesel.

4040T WATER COOLING SYSTEM:
Ensure cooling system cools engine when running on continuous full load and on 10% overload for one hour.
  Radiator
    Air blast type, complete with integral header, sealed.
    Pressurized.
    Provide flange for ductwork on radiator discharge.
  Radiator mounting
    Set mounted with engine driven fan upstream of radiator.
  Pumps
    Provide engine driven pump to circulate jacket water through radiator.
  Valves
    Provide a thermostatically controlled diverting valve in engine cooling water discharge pipework with by-pass to circulating pump suction.
  Drain points
    Provide drain points at low points in engine cooling water system.
4060T FUEL SYSTEM:

Provide a set mounted fuel tank

Tank Capacity
Fuel for running set on full load for 8 hours.

Tank fittings
Outlet/jettison connection.
Dial type contents gauge.
Overflow connection.
Injector spill and excess fuel return connection.
Filling connection.
Bolted access cover.
Drain plug.
Vent with gauze flametrap.
Provision for fitting float controlled fuel oil transfer pump switch and float-controlled high level alarm switch. Fit holes with gasket and bolted covers.

Fuel filter
Provide fuel filter, to BS 4552, with disposable filter elements, fitted in fuel inlet pipe.

Ensure engine fuel system is isolated and cannot contaminate engine lubricating oil.

4070T ENGINE LUBRICATION:

Provide automatic engine lubrication using an integral gear driven pump.
Provide coarse strainer on suction side and full flow filter on delivery side.
Ensure engine lubricating oil dipstick is accessible and marked to indicate maximum and minimum levels.
Provide engine sump with accessible drain point or drain pipe, fitted with plug.
Provide electric motor driven lubricating priming pump with automatic intermittent time control to keep engine bearings lubricated.
Ensure lubricating oil system enables the engine to run continuously for period indicated at any load without replenishment. Ensure system can be replenished while engine is running.

4080T ENGINE STARTING SYSTEM:

Provide 24 volt dc supply to start engine from any crankshaft position, by axial type starter motor engaging with flywheel. Ensure starter motor disengages automatically when engine starts or when de-energized.
Ensure starter motor is accessible and fit non-conducting protective shrouds to terminals.
Ensure system has sufficient Capacity to initiate three starting cycles.

Heater
Fit thermostatically controlled electric heater in engine, in accordance with manufacturer's recommendations.

4100T EXHAUST SYSTEM:

Provide exhaust system in accordance with manufacturer's recommendations and to meet characteristic requirements. Include all fittings, gaskets, joints and fixings.

Material
Black mild steel.

Exhaust system characteristics.
Noise limitations: Residential

4120T AUTOMATIC VOLTAGE REGULATOR:

Provide solid state type automatic voltage regulator with manual adjustment to set alternator output within indicated percentage of rated voltage.

Percentage of rated voltage +/-5%.

Mounting
On alternator.

Provide enclosure for regulator components isolated from generator using anti-vibration mountings.

5000 WORKMANSHIP

5010 GENERATOR SET:
Install generator set in accordance with manufacturer's recommendations.
Ensure set is positioned to allow on-site maintenance and repairs, including barring facility where indicated. Provide access for removal of pistons and connecting rods.

5020 FUNCTIONAL TEST REPORT:
Provide completely documented ISO standard functional test report in accordance with BS 7698 Part 6.

5030 ACCEPTANCE TEST:
Carry out acceptance tests and provide Acceptance Test Report in accordance with BS 7698 Part 6 and the specified requirements.
Acceptance test.
Manufacturer works.
  Using test bed switchgear.
  Using set's own switchgear.
  Without electrical load.
At site of installation.

5040 TESTING AND COMMISSIONING:
The installation works shall be tested and verified by the commissioning authority.
This section is to be read in conjunction with the Design Brief/Report and the relevant drawings.

PART 1 SYSTEM OBJECTIVES

This part describes the 11kV supply to the premises.

The supply shall be taken from nearby utility at 11kV through a 5-section 11kV panel in the HV/LV Room. Surge diverter will be provided in the panel.

Two PHCN 11kV lines are to be taken to the site – a duty/standby arrangement.

1010 SYSTEM DESCRIPTION

Utility power shall be taken into the premises at 11kV.

This is then stepped-down to 0.415kV and distributed through a main Low voltage panel.

Load distribution shall be affected through 2No 650kVA(duty/standby) , 11/0.415kV, transformers.
V20 LV DISTRIBUTION

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES

The system shall commence from the main LV panel.

Ease of maintenance as well as adequate cable and cabling management shall be given high priority in the system planning. Following this, the proposed system shall be such that minimal disruption shall apply except for periods of major maintenance works.

Adequate system control for the protection of life and property shall be taken into consideration.

1030 SYSTEM DESCRIPTION

At major load centers, the power shall terminate in sub main panels and distribution boards where applicable. Power to main equipment will be by direct feeds from the sub-main panels. Power to essential safety equipment (fire pumps, fireman’s lifts, etc) shall be by direct feeds from dedicated sub-main panels.

There shall be Floor distribution panel(s) for each floor located in the electrical room (or cupboard) as necessary. The local Floor panels for each floor shall feed the distribution boards local to the floor and some other fixed equipment also on the same floor.

The standard calls for provision for sub-metering of distribution boards and sub-panel serving loads in excess of 50kW. We propose to have sub-meters on the supplies to the main office building sub-panel.

1040 CONTROL REQUIREMENTS

Facilities shall be provided to interrupt power supply to air movement equipment via a control signal from the Fire Alarm Control Panel during emergency fire periods.

1060 SYSTEM DRAWINGS

As listed in the schedule of drawings.

AfDB: Electrical Specifications
PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2600 CONDUIT AND TRUNKING

2601 CONDUIT AND TRUNKING GENERALLY:
Comply with work section Y60 General clauses and those detailed below.

2603 CONDUIT AND TRUNKING SPECIFICATION:
Supply conduit and Cable trunking as specified in section below.

2605T CONDUIT:
Type: rigid, uPVC
Application
- Buried conduit for Cables to final sub-circuits.

Manufacturer and reference
- MK
- Or approved equivalent
Non-metallic
- Rigid
  - Reference Y60.2030A
- Fittings and accessories
  - Reference Y60.2060A
Support and fixing - reference Y60.2170
Workmanship
- General
  - Reference Y60.3010A
- Layout - reference Y60.3020
- Spacing - reference Y60.3030
- Condensation prevention - reference Y60.3040
- Equipment connections - reference Y60.3060
- Cleaning before wiring - reference Y60.3070
- Wiring
  - Reference Y60.3080A
- Builders work - reference Y60.3090
Workmanship for conduit
- Draw-in boxes - reference Y60.4010
- Installation of Cast in or buried conduit
  - Reference Y60.4020
- Conduit boxes - reference Y60.4030
- Fixing conduit - reference Y60.4040
Flexible and pliable conduit
   Reference Y60.4050
Non-metallic conduit
   Reference Y60.4070A
2610 HV/LV CABLES AND WIRING

2611 HV/LV CABLES AND WIRING
Comply with work section Y61 General clauses and those detailed below.

2613 HV/LV CABLES AND WIRING SCHEDULE:
Supply HV/LV Cables and wiring as schedule reference below.

2615T STANDARD FLEXIBLE CORDS AND INDUSTRIAL CABLES:
Type: TPE/TPE Cables.
Application
- Connection from ceiling rose to lighting fittings.
Manufacturer and reference
KabelMetal, MicCom
Or approved equivalent
Standard ordinary flexible cords - multi-core
Reference Y61.2010D

2617A STANDARD WIRING AND POWER CABLES:
Type A: TPE singles and multicore.
Application
- Supply to final sub-circuits.
- Supply from switchboards to distribution boards.

Manufacturer and reference
KabelMetal, MicCom or approved equivalent
Standard power supply Cables
TPE insulation
- Sheathed - reference Y61.2020C
- Sheathed and armoured - reference Y61.2020D
Standard wires for conduit and trunking
TPE insulated - reference Y61.2020F
Standard Cables required to maintain circuit integrity under fire conditions
Reference Y61.2020L
2617B STANDARD WIRING AND POWER CABLES:
Type B: TPE/SWA/TPE
Application
- supply from main panel to main switchboard, DB’s etc.

Manufacturer and reference
KabelMetal, MicCom
Or approved equivalent
Standard power supply Cables
PVC insulation
Sheathed - reference Y61.2020C
Sheathed and armoured - reference Y61.2020D
Standard Cables required to maintain circuit integrity under fire conditions
Reference Y61.2020L

261RT CABLE GLANDS:
Unarmoured Cables, indoors - reference Y61.3010A
Unarmoured Cables, outdoors - reference Y61.3010B
Armoured Cables, dry indoors - reference Y61.3010C
Armoured Cables, indoors - reference Y61.3010D
Armoured Cables, outdoors - reference Y61.3010E

261XT CABLE TERMINATING AND JOINTING SOCKETS:
Reference Y61.3040A

261bT CABLE JOINTS AND TERMINATIONS:
Reference Y61.3060A

261r WORKMANSHIP
Cable installation - general - reference Y61.4010
Cable installation in low temperatures
Reference Y61.4020
Installation of unarmoured Cables.
Reference Y61.4040
Cable ducts.
Reference Y61.4070A
Cable installation into ducts - reference Y61.4080
Cable installation in conduit and trunking.
Cable installation on tray and rack
Reference Y61.4100
Cable embedded installation.
Reference Y61.4120A
Cable installation - flexible cords.
Reference Y61.4140
Cable jointing and terminating generally.
Reference Y61.4150A
Cable sleeves - reference Y61.4210

2630 SUPPORT COMPONENTS - CABLE

2631 SUPPORT COMPONENTS - CABLES GENERALLY:
Comply with work section Y63 clauses detailed below.

2633 SUPPORT COMPONENTS - CABLES SPECIFICATION:
Supply support components as specified in section below.

2637T CABLE SUPPORT SYSTEM:
Type: Perforated tray.
Application
- Soffit suspended runs in surface and equipment rooms.
- Vertical surface Cable runs in electrical/data ducts.

Manufacturer and reference
Even Ezra, Metal Furniture Nig. Ltd.
Or approved equivalent
Perforated tray - reference Y63.2020A
Cable rack - reference Y63.2020B
Cable cleats - reference Y63.2020C
Proprietary Cable ties - reference Y63.2020D
Cable clips - reference Y63.2020E
Two way saddles - reference Y63.2020F

2639 WORKMANSHIP
Cable tray installation - reference Y63.3010
Cable cleats, ties, saddles and clips installation
Reference Y63.3020A
2710 LV SWITCHGEAR AND DISTRIBUTION BOARDS

2711 LV SWITCHGEAR AND DISTRIBUTION BOARDS GENERALLY:
Comply with work section Y71 clauses detailed below.

2713 SWITCHBOARD AND DISTRIBUTION BOARD SCHEDULE:
Supply switchboards and distribution boards as schedule reference: on the drawings.

2717T SWITCHBOARD:
Type: MCCB
Application
- Sub-main Boards.

Manufacturer and reference
Legrand, Mane, Siemens
Or approved equivalent

Electrical supply
(ph): 3.
(volts): 400.
(Hz): 50.

LV switchgear and control gear assembly
Standard
BS EN 60439-1.

External design
Cubicle type assembly.
or Multi-cubicle type assembly.

Usage
Switchboard.
or Control panel.

Conditions of installation
Indoors.

Electrical characteristics
Rated operational voltage (V): 400 +10%/-6%.
Rated current (A): as indicated.
Rated diversity factor: 0.8
BS 5486 Part 1, section 4.8.

Service conditions
Ambient air temperature as BS EN 60439.
Altitude as BS EN 60439.

Provide facilities to allow future extension of switchboard on both sides.
Assembly construction
Material of enclosure
  Manufacturer's standard.
  Steel.
Terminals for external conductors, main power circuits
  Accommodate cross-sectional area of copper cables in accordance with BS EN 60439-1.
Terminals for external conductor, control and auxiliary circuits
  Terminal block.
  Mounting.
  Manufacturer's standard.
Size of neutrals on three phase supplies
  Full current-Carrying Capacity of phase conductor if size of phase conductor is less than or equal to 16mm².
Degree of protection to BS EN 60529
  For assembly IP31.
Protection against direct contact
  Manufacturer's standard.
Protection against indirect contact
  Manufacturer's standard.
Accessibility for inspection
  Arrange for following operations to be performed when assembly is in service and under voltage.
    Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
    Adjusting and re-setting of relays, releases and electronic devices.
    Replacement of indicating lamps.
    Fault Location by voltage and current measuring.
Accessibility for maintenance
  Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
Removable parts and withdrawable parts
  Degree of protection of assembly after removal or withdrawal of part as manufacturer's standard.
Internal separation
  Form 4.
Input voltage variations for electronic equipment supply
  BS EN 60439.
Supply frequency deviation
BS EN 60439.

Mounting
  - Floor standing.
  - or Wall mounted.

Access for Cabling
  - Front.
  - Top.
  - Bottom.
  - or Rear.

Enclosures finish
  - Apply high standard finish to enclosure and supporting metalwork.
  - Degrease metal and remove rust prior to applying finish.
  - Comply with paint manufacturer's recommendations regarding preparation, stoving times, temperatures, mixing of finishes, application and coat thickness.

Finish
  - Manufacturer's standard.

Colour
  - Manufacturer's standard colour.

Sample
  - Provide specimen steel frames and panels for each stage of each type of paint system and for each colour.

Type tests
  - Provide certificates of verification of

Routine test
  - Carry out test on site.

Site built assemblies - reference Y71.2040
Site modification - reference Y71.2050

271DT SWITCHES, DISCONNECTORS AND FUSE COMBINATION UNITS:

Application
  - connection to fixed equipment.

Manufacturer and reference
  - MK, Legrand, MEM
  - Or approved equivalent

Supply switches, disconnectors and fuse combination units in accordance with BS EN 60947. Fit fuse combination units with Cartridge fuse links in accordance with BS 88 (BS EN 60269).

Standard
  - BS EN 60947-3
Details of equipment.
  Equipment.
   Switch-disconnector.
   Fuse combination unit.
   Switch-fuse.
   Fuse-switch.
  Number of poles : as shown on drawings.schedules.
  a.c.
  Interrupting medium.
   Air.
Rated and limiting values for the main circuit.
  Rated voltage (Volts).
   Operational : 400/230V
  Currents (Amps).
  Rated operational.
   Current (Amps) : as indicated on drawing.
  Rated frequency (Hertz) : 50Hz.
  Rated duty.
   Uninterrupted.
Normal load and overload characteristics.
  Motor switching overload current withstand (Amps) : as shown on the drawing.
  Rated making Capacity (Amps) : as shown on the drawing.
  Rated breaking Capacity (Amps) : as shown on the drawing.
Utilisation Category.
  AC 23A.
Auxiliary circuits : as shown on drawings.
Fit each switch with facility to padlock in OFF position.
Provide switches with auxiliary contacts as indicated. Where switches isolate final connections between a starter and its motor, fit one set of contacts to open starter coil circuit when switch is opened.

271XT DISTRIBUTION BOARDS:
Type : MCB type with copper busbars.
Application
  - Lighting & Small power points.

  - Power supply to air-conditioning units.

Manufacturer and reference
  MK, Legrand, MEM, ABB, Schneider Electric or approved equivalent
Electrical supply
  Phase: 1 or 3.
  Voltage (V): 230 or 400
  Frequency (Hz): 50
Reference Y71.2200.

Distribution board
  Internal separation
    Form 1
  Spare ways: 25% or as shown on drawing.

Enclosures finish
  Apply high standard finish to enclosure and supporting metalwork.
  Degrease metal and remove rust prior to applying finish.
  Comply with paint manufacturer's recommendations regarding preparation, stoving times, temperatures, mixing of finishes, application and coat thickness.
  Finish
    Manufacturer's standard.
  Colour
    Manufacturer's standard colour.

271bT MINIATURE CIRCUIT BREAKERS:
  Type: 3(7kA)
  Application
    Final circuit protection.
  Manufacturer and reference
    Legrand, Schneider Electric, MEM, MK or approved equivalent
  Standard
    BS EN 60898.
  Duty in accordance with BS EN 60898
    Current rating: as shown on drawing.
    Type according to instantaneous tripping current: 3(7kA).

271dT RESIDUAL CURRENT DEVICE:
  Manufacturer and reference
    Legrand, Schneider Electric, MEM, MK
    Or approved equivalent
  Standard
    BS 4293
  Duty
    Rated voltage: as shown on drawing.
Rated current: as shown on drawing.
Rated tripping current: as shown on drawing.
Rated tripping time: as shown on drawing.
Rated breaking Capacity: as shown on drawing.

Overcurrent protection
Fit RCD's with integral overcurrent protection.

**271f CABLE TERMINATIONS:** Reference Y71.2240

**271p WORKMANSHIP**
- Fixing - reference Y71.3010
- Mounting height - reference Y71.3020
- Access - reference Y71.3030

Marking and drawing
- Number terminals, Cables and component parts to correspond with manufacturer's certified drawings.
- Prepare drawings for switchgear and controlgear in accordance with BS EN 61082.

Cable terminations - reference Y71.3050

Installation and commissioning
- Install and commission switchgear and controlgear in accordance with the appropriate standard and the manufacturers recommendations. Include CT Polarity check in commission tests.
- Engage specialist to commission switchboards.
- Equipment manufacturer.
- Engage specialist to commission controlgear and motor control centres.
- Panel assembler.

**2800 EARTHING AND BONDING COMPONENTS**

**2801 EARTHING AND BONDING COMPONENTS:**
Comply with work section Y80 general clauses and those detailed below.

**280D WORKMANSHIP:**
- Clean earth distribution - reference Y80.3010
- Dissimilar metals - reference Y80.3020
- Tape joints
  - Reference Y80.3030A
- Stranded conductor joints - reference Y80.3040
- Protective Cable terminations
  - Reference Y80.3050A
Earth electrodes
Reference Y80.3060A

2810 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

2811 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

GENERALLY:
Comply with work section Y81 clauses detailed below.

2815 TESTING AND COMMISSIONING:
Inspection and test procedure - reference Y81.1010
Incorporated equipment characteristics
Design information - reference Y81.1050
Initial verification
Reference Y81.1060A
Test equipment and consumables
Reference Y81.1070A
Testing
Reference Y81.1080A
Continuity of protective conductors
ac or dc - reference Y81.1090A
Earth fault loop impedance (ZS)
Reference Y81.1100A
Settings and adjustments - reference Y81.1110
calibration - reference Y81.1160
Certification and reporting
Reference Y81.1170A
Completion certificates
Reference Y81.1180A
Records - reference Y81.1190

2817 WORKMANSHIP:
Conductive parts - reference Y81.2010
Phase sequence - reference Y81.2020
Cables
LV buried Cables - references Y81.2040A
Conduit, trunking and ducting - reference Y81.2050
IDENTIFICATION - ELECTRICAL

IDENTIFICATION - ELECTRICAL GENERALLY:
Comply with work section Y82 clauses detailed below.

LABELS AND NOTICES:
Reference Y82.1010A

LABELS AND NOTICES MATERIALS:
- Material
  Reference Y82.1020A
- Fixing
  Reference Y82.1030A
- Arrangement
  Reference Y82.1040A
- Lettering and size of labels and notices
  Reference Y82.1050A

CONDUCTOR ARRANGEMENT:
Reference Y82.1060

EQUIPMENT SIGNS AND LABELS:
- Safety signs
  Reference Y82.2010A
- Plant and equipment labels
  Reference Y82.2020A
- Maintenance notices - reference Y82.2030
  Equipment Sub-main Boards.
- Motors and starters labels
  Reference Y82.2050A
- Engraved accessory plates
  Reference Y82.2060A
- Switchgear
  Reference Y82.2070A
- Distribution boards - reference Y82.2080

SCHEMATIC DIAGRAMS:
Reference Y82.2090A
282DT SPECIAL PURPOSE EARTHING:
   Application
   Earthing of ancillary service equipment.
   Reference Y82.2100A

282J CABLE IDENTIFICATION:
   Cable identification
   Reference Y82.2130A
   Terminal marking and conductor identification
   Reference Y82.2140A
   Underground Cable identification
   Reference Y82.2150A
   Cable conductor colour coding
   Reference Y82.2160A
   Cable jointing and termination - reference Y82.2170
   Cable sheath identification - internal
   Reference Y82.2180A
   Cable sheath identification - external
   Reference Y82.2190A

282LT ADDITIONAL SAFETY SIGNS:
   Reference Y82.2200A

2830 TESTING AND COMMISSIONING:
   The installation works including all the meters shall be tested and verified by the commissioning authority.
V21 GENERAL LIGHTING

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES
Artificial means will be provided for general interior and exterior lighting and as well as aesthetic purposes.

Illumination will be designed to be compatible with architectural and interior design concepts but generally, in compliance with CIBSE Codes for internal and external lighting of hospitals.

1030 SYSTEM DESCRIPTION
Generally, interior lighting will be provided using LED lamps and other energy saving lamps options.

Recessed down lighters fitted with compact fluorescent or LED lamps will be provided in the Reception Hall, corridors and lift Lobbies etc.

Emergency units and as required, will be integral to the normal lighting luminaires. These emergency luminaires will come on automatically in the events of the mains failure and go off when the electricity supply is restored. Built-in chargers automatically re-charge the batteries when power is present. The batteries are sized to provide light for a minimum of 3 hours.

Maintained exit and direction signs will be provided along all escape routes.

The specified lightings fittings in the BOQ are for guidance purposes only as the final selection is to be approved by the Bank.

1040 CONTROL REQUIREMENTS
System switching shall be as shown on the drawing.

1060 SYSTEM DRAWINGS
As per the attached schedule of drawings.
PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2730 LUMINAIRES AND LAMPS

2731 LUMINAIRES AND LAMPS GENERALLY:
Comply with work section Y73 General clauses and those detailed below.

2733 LUMINAIRES AND LAMPS SCHEDULE:
Supply luminaires and lamps in accordance with schedule reference: Schedule of Legend and Bills of Quantities.

2735A LUMINAIRES:
Type A:
Application
- LED and other energy saving lamp options for general purpose lighting as shown.
- Downlighters for general purpose and aesthetic lighting as shown on drawings.

Manufacturer and reference
Fitzgerald, THORN, ASTRA, MARLIN or approved equivalent
General purposes - reference Y73.2010A.

2735B LUMINAIRES:
Type B:
Application
- emergency units with exit signs.
- self contained emergency luminaires.
- fluorescent luminaires with integral emergency units.

Manufacturer and reference
Fitzgerald, THORN, ASTRA, BEKA, MARLIN or approved equivalent
General purposes - reference Y73.2010A.
Special applications - reference Y73.2010C
Emergency lighting
Reference Y73.2020A
Exit signs - reference Y73.2030

2737T LAMPHOLDERS:

General - reference Y73.2060

AfDB: Electrical Specifications
Tungsten fittings - reference Y73.2070
Mounting
Reference Y73.2080A

2739T CONTROL GEAR AND COMPONENTS:

Compatibility
Reference Y73.2090A
Fluorescent lamp ballasts and starters
Reference Y73.2100A
Discharge lamp ballasts and starters
Reference Y73.2110A
capacitors
Reference Y73.2120A
Supply terminals - reference Y73.2130
Fuse - reference Y73.2140
Interference - reference Y73.2150
Remote gear - reference Y73.2160

273BT LAMPS:

LED lamps
Reference Y73.2170A
Fluorescent lamps
Reference Y73.2180A
High pressure mercury vapour lamps
Reference Y73.2190
High pressure sodium vapour lamps
Reference Y73.2200
Low pressure sodium vapour lamps
Reference Y73.2210
Transformers for LV luminaires
Lamp manufacturer - reference Y73.2230

273DT SUPPORT SYSTEM:

Conduit
Steel - reference Y73.2240A
Installation
Support from conduit - reference Y73.4120
Suspension - reference Y73.4160
Connections to luminaires - reference Y73.4220
   Direct to conduit
     Terminal box - reference Y73.4230A
     At luminaire - reference Y73.4230B
   Conduit suspension - reference Y73.4270

Rod
   Cadmium plated steel - reference Y73.2250A
   Installation
     Suspension - reference Y73.4160
     Suspension by rod - reference Y73.4170
     Connections to luminaires - reference Y73.4220
     Rod or chain suspension
     Reference Y73.4280

Chain
   Cadmium plated steel - reference Y73.2260A
   Installation
     Suspension - reference Y73.4160
     Suspension by chain - reference Y73.4180
     Connections to luminaires - reference Y73.4220
     Rod or chain suspension
     Reference Y73.4280

Flexible cord
   Reference Y73.2270A
   Installation
     Suspension - reference Y73.4160
     Suspension by flexible cord
     Reference Y73.4190

Wall brackets
   Reference Y73.2280A
   Installation
     Installation of wall mounted fittings
     Reference Y73.4050
     Height : as specified on drawings.

273HT LUMINAIRES AND LAMPS ACCESSORIES:

  Integral photo-cells - reference Y73.3020

273JT LUMINAIRES AND LAMPS WORKMANSHIP - GENERAL:

  Orientation - reference Y73.4010
  Cleanliness - reference Y73.4020

AfDB: Electrical Specifications
Material of supporting surface
  Reference Y73.4060
Luminaires in areas with infra-red control system
  Reference Y73.4080
Installation of extra low voltage tungsten halogen lamps - reference Y73.4100
Support - reference Y73.4110
Support by direct fixing
  Reference Y73.4140A
Support in suspended ceiling
  Reference Y73.4150A
Connections to luminaires - reference Y73.4220
Lighting switches on different phases
  Separate - reference Y73.4300A
  Phase barrier - reference Y73.4300B

273LT LUMINAires AND LAMPS WORKMANSHIP - RECESSED FITTINGS:
  Installation of recessed fittings
    Reference Y73.4030
  Installation of semi-recessed fittings
    Manufacturers’ details - reference Y73.4040A
  Connections to luminaires - reference Y73.4220
    Recessed fittings
      Plug and socket - reference Y73.4260A
      Terminal box - reference Y73.4260B

273NT LUMINAires AND LAMPS WORKMANSHIP - ON TRUNKING:
  Support - reference Y73.4110
  Support from trunking - reference Y73.4130
  Connections to luminaires - reference Y73.4220
    Direct to trunking
      Terminal box - reference Y73.4240A
      At luminaire - reference Y73.4240B
    Suspended from trunking - reference Y73.4250
2740 **ACCESSORIES FOR ELECTRICAL SERVICES**

2741 **ACCESSORIES FOR ELECTRICAL SERVICES GENERALLY:**
Comply with work section Y74 General clauses and those detailed below.

2747 **SAMPLES:**
Provide samples of the following items
- Lighting Fittings.
- switches.
- Any other item as may be required by the Consultant.

2749T **ACCESSORIES COMMON REQUIREMENTS:**
White plastic plates, flush installation.
Reference Y74.2010A
White plastic plates, embedded Cables, surface installation - reference Y74.2010C
Surface, plastic, weatherproof installation.
Reference Y74.2010F
(colour of the accessories are to be as approved by the Bank).

274BT **INTERIOR LIGHTING SWITCHES:**
General purpose - reference Y74.2020A
Grid - reference Y74.2020B
Pull cord - reference Y74.2020C

274FT **TIME SWITCHES:**
24 hour - reference Y74.2040A
7 day - reference Y74.2040B

274HT **LUMINAIRE CONNECTORS:**
General and emergency lighting - reference Y74.2050A
General lighting - reference Y74.2050B
Cord grip general and emergency lighting.
Reference Y74.2050C

274JT **LAMPHOLDERS:**
BC type - reference Y74.2060A
ES type - reference Y74.2060B
274LT ISOLATING SWITCHES:

BS 3676 Part 1 - reference Y74.2070A
BS EN 60947-3 - reference Y74.2070B

274p WORKMANSHIP:

Earthing - reference Y74.3010
Protection - reference Y74.3020
Fixing - reference Y74.3030
Measuring mounting heights - reference Y74.3040
Mount electrical accessories
  As indicated on Architectural drawings.
  As indicated on the drawings/schedules.

2800 EARTHING AND BONDING COMPONENTS

2801 EARTHING AND BONDING COMPONENTS:
Comply with work section Y80 general clauses and those detailed below.

2805T CONDUCTORS:

Conductors for earthing systems to BS 7430.
  Reference Y80.2010C
Conductor joints
  Reference Y80.2020A
Tape fixing devices
  Reference Y80.2030A

280BT EARTHING:

Circuit protective conductors
  Reference Y80.2110A
Protective Cable terminations - reference Y80.2160

280D WORKMANSHIP:

Clean earth distribution - reference Y80.3010
Dissimilar metals - reference Y80.3020
Tape joints
  Reference Y80.3030A
Stranded conductor joints - reference Y80.3040
Protective Cable terminations
Reference Y80.3050A
Earth electrodes
Reference Y80.3060A

2810 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

2811 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
GENERALLY:
Comply with work section Y81 clauses detailed below.

2817 WORKMANSHIP:
Conductive parts - reference Y81.2010
Conduit, trunking and ducting - reference Y81.2050
PART 3 SPECIFICATION CLAUSES SPECIFIC TO V21.

3000 GENERAL

3010 SYSTEM REQUIREMENTS:
Select lighting control equipment suitable to meet system objectives requirements.

3030 LIGHTING CONTROL EQUIPMENT SCHEDULES:
Supply lighting control equipment in accordance with the specifications.

5000 WORKMANSHIP

5010 INSTALLATION:
Install lighting control equipment in accordance with manufacturer's recommendations.

5020 TESTING AND COMMISSIONING:

The installation works shall be tested and verified by the commissioning authority.
PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES
1. Provision of general purpose power to small appliances and office equipment.

2. Provision of 3 phase supply to areas of demand.

1030 SYSTEM DESCRIPTION

In general, electrical installation will be installed flush within the building fabric except in plant rooms, risers and cupboards. Provision will be made for supplies to miscellaneous equipment, i.e. Fire alarm Panels, W.C. warm air hand driers etc. Draw wires will be included in empty containment for future rewiring.

Power will be provided at either 230V, single phase or 400V, three phase.

Single phase supplies will generally be provided by use of 13A switch-socket outlets. However, where appliances which require a power supply are of a permanently fixed nature, these will be supplied from switched spur units.

Except for the switched spur units, which will be wired in radial circuits, 13A switch-socket outlets will be in ring main.

Cleaner sockets will be located at selected places.

Three phase supplies will generally only be required for large items of plant and will be fed directly from the main LV panel or local sub-main board. Three phase supplies will generally terminate in isolating switches adjacent to the equipment being served. The final connection to the equipment will be carried out by the equipment suppliers or installers.

1060 SYSTEM DRAWINGS
As listed in the Schedule of drawings.
PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2740 ACCESSORIES FOR ELECTRICAL SERVICES

2741 ACCESSORIES FOR ELECTRICAL SERVICES GENERALLY:
Comply with work section Y74 General clauses and those detailed below.

2747 SAMPLES:
Provide samples of the following items
all materials to be installed including Cables and wiring accessories.

2749T ACCESSORIES COMMON REQUIREMENTS:
White plastic plates, flush installation.
   Reference Y74.2010A
Metal plates, flush installation.
   Reference Y74.2010B
White plastic plates, embedded Cables, surface installation - reference Y74.2010C
Metal clad plates, surface steel conduit installation.
   Reference Y74.2010D
Surface, steel conduit, weatherproof installation.
   Reference Y74.2010E
Surface, plastic, weatherproof installation.
   Reference Y74.2010F
(colour of the accessories are to be as approved by the Bank).

274PT SOCKET-OUTLETS:
Single, switched - reference Y74.2090A
Double, switched - reference Y74.2090C

274p WORKMANSHIP:
Earthing - reference Y74.3010
Protection - reference Y74.3020
Fixing - reference Y74.3030
Measuring mounting heights - reference Y74.3040
Mount electrical accessories
   As indicated on Architectural drawings.
   As indicated on the drawings/schedules.
   In accordance with clause reference Y74.3050
2800 EARTHING AND BONDING COMPONENTS

2801 EARTHING AND BONDING COMPONENTS:
Comply with work section Y80 general clauses and those detailed below.

280BT EARTHING:

- Circuit protective conductors
  Reference Y80.2110A
- Protective Cable terminations - reference Y80.2160
- Protective conductor warning notices/labels
  Reference Y80.2170
- Main earth conductor - reference Y80.2180

280D WORKMANSHIP:

- Clean earth distribution - reference Y80.3010
- Dissimilar metals - reference Y80.3020
- Tape joints
  Reference Y80.3030A
- Stranded conductor joints - reference Y80.3040
- Protective Cable terminations
  Reference Y80.3050A
- Earth electrodes
  Reference Y80.3060A
2810 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

2811 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
   GENERALLY:
   Comply with work section Y81 clauses detailed below.

2813 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES
   SPECIFICATION:
   Carry out testing, verification and commissioning of electrical services as section

2815 TESTING AND COMMISSIONING:
   Inspection and test procedure - reference Y81.1010
      Incorporated equipment characteristics
         Reference Y81.1020A
      Initial verification
         Reference Y81.1060A
      Test equipment and consumables
         Reference Y81.1070A
      Testing
         Reference Y81.1080A
      Continuity of protective conductors
         ac or dc - reference Y81.1090A
      Earth fault loop impedance ($Z^S$)
         Reference Y81.1100A
      Calibration - reference Y81.1160
      Certification and reporting
         Reference Y81.1170A
      Completion certificates
         Reference Y81.1180A
      Records - reference Y81.1190

2817 WORKMANSHIP:
   Conductive parts - reference Y81.2010
   Phase sequence - reference Y81.2020
   Cables
      LV buried Cables - references Y81.2040A
      LV and HV buried Cables - references Y81.2040B
PART 1 SYSTEM OBJECTIVES

1010 SYSTEM DESCRIPTION

Dedicated or integral UPS power supplies shall be made available to the following:

- Workstations
- Technical equipments
- Fire and Voice Alarm Systems
- Public Address System
- CCTV and Control Systems

A central UPS system shall be provided for the office operational services. This shall include the IT systems (data and voice) as well as the management systems.

All central UPS shall be of the 100% parallel redundancy configuration. Batteries are to be sized to sustain full load for 60 minutes.

The UPS equipment shall be fitted with under voltage and over current protection.

1020 TESTING AND COMMISSIONING:

The installation works shall be tested and verified by the commissioning authority.
W50 FIRE DETECTION AND ALARM SYSTEM

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES

An automatic means for detection of fire incidents at the early stage will be provided for the development. Further to this, a programmable, modular fire detection and alarm system will be provided.

1030 SYSTEM DESCRIPTION

The Fire Detection and Alarm system for the building shall form part of the Fire and Life Safety System (FLS) for the development.

The Fire Alarm (FA) installations in Nigeria are designed to comply with all statutory regulations including BS 5839.

Generally, the system shall include the following:

- A fully analogue addressable fire alarm control panel to BS 5839
- Repeater panel
- Emergency paging and voice alarm system.
- Fire alarm visual/sounder signaling devices, smoke detectors, heat detectors and manual call points (at all fire exits), detectors in ceiling voids and ducts (for air handling units).
- Interfaces with plant controls
- Linkage to magnetic/electric locks on all access controlled doors

Automatic fire detectors shall be provided throughout the building. In addition, manual break glass units will be provided along exit routes.

Visual/sounder alarm signalling devices shall work in coordination with the voice alarm speakers that are located throughout the development. The voice alarm shall provide ‘alert’ and ‘evacuate’ tones and messages. The visual devices shall consist of solid state Xenon Strobe lights rated at 75 candela minimum.
The sounders shall be located such that audible signals can be clearly heard in the public areas. The audible alarms shall achieve 65dBA in all locations.

*In the event of a fire, all the alarm sounders shall initially be rung intermittently. If the fire is confirmed, the sounders shall then be rung continuously signifying that the building is to be evacuated.*

In designated disabled occupancies, emergency pull cords and push buttons shall be provided.

In addition, the fire alarm panel shall be linked to the sprinkler fire fighting system.

The system shall also be linked to the airconditioning units such that these are automatically shut down in the event of fire. The system shall also activate the smoke control system.

The FAS shall be integrated on the BMS for monitoring purposes only. No control of the FAS shall be available through the BMS.

The system shall be wired in call zone loops. Each of the call zone loops shall be capable of driving up to 126-field addressable device.

A Remote Repeater Panel shall be located in the Security Room and the Engineering Office.

Indicator Panels (both audio and visual) shall be located in the Security Office and at the Front Desk.

The FA system shall be complete with an emergency call system. This shall automatically dial emergency numbers and relay pre-recorded messages.

The Fire Detection and Alarm system shall be such that on detection of fire by either an automatic device or a manual Call point, a general alarm shall be sounded. An indication and location of the device which triggered the alarm shall be displayed on the Control panel.

The panel shall monitor all connected devices on a continuous basis for faults and degraded performance.

Faults and out of specification reports shall sound an audible alarm on the panel, and
also preferably produce a printed report from built-in printer.
The panel shall also have facilities for keeping a history of all alarms and faults.

1040 CONTROL REQUIREMENTS
The system will be linked to one of the lifts so that this turned off in the event of a fire.

1060 SYSTEM DRAWINGS
As listed in Schedule of Drawings.

PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2600 CONDUIT AND TRUNKING

2601 CONDUIT AND TRUNKING GENERALLY:
Comply with work section Y60 General clauses and those detailed below.

2611 LV CABLES AND WIRING
Comply with work section Y61 General clauses and those detailed below.
PART 3 SPECIFICATION CLAUSES SPECIFIC TO W50.

3000 GENERAL

3010 TYPE OF SYSTEM:

Standard
BS 5839 Part 1.
Type L - Protection of life.
L1: systems installed throughout the protected building.

3050 EXPLOSIVE OR FLAMMABLE ATMOSPHERES:
Where fire alarm equipment or wiring are installed in areas where explosive or flammable atmospheres occur comply with BS 5345.

3060 MONITORING:
Provide all end of line and other circuit elements to ensure the system is fully monitored to comply with BS 5839.

3080 REMOVAL OF TRIGGER DEVICE:
Provide precautions against removal of trigger devices.
Use trigger devices wired on circuits separate from manual Call points.
Use trigger devices that are removed only by a special tool.
Use trigger devices with bases that provide circuit continuity with trigger device removed.
Ensure that, where alarm sounders use same wiring as trigger device, removal of trigger device does not affect operation of alarm sounder.

3100 REMOTE CENTRE:
Make provision to send signal to remote centre.
Location: Gatehouses
Signals
Alarm.
LED.

3110 FIRE ALARM SPECIALIST:
Engage a specialist to develop the design, supply, install, commission and set to work the fire alarm system.
4000 PRODUCTS/MATERIALS

4010T MANUAL CALL POINTS:
Type: Microprocessor based, monitored.

Manufacturer and reference
Gent 3480
Or approved equivalent
Standard
BS 5839 Part 2.
Mounting
Flush.
Surface.
Hinged cover.
Switch contact
Make.
or Break.
Degree of Protection to BS EN 60529.
Operation
MCP activation response within
1 second.
Field programmable to trigger alert or evacuate alarms.
Addressable.
Monitored.
Manual operation
Break glass.
Anti-fragmentation film.
Thumb pressure.
End of line device mounted in mcp.

4020 AUTOMATIC DETECTORS
Provide automatic fire detectors from the same manufacturers and with common facilities.
Plug in bases.
Common base for all detector types.
2 way.
3 way or "T".
Mechanical device to accept only;
Optical smoke detectors.
Ionisation smoke detectors.
Heat detectors.
Sounder.
Detectors locking.
Communicate detector status & address to Fire Alarm Control Panel.
Address code setting
  Automatic.
  Software.
  Separate addressable plug for each detector.
Visible activation indicator.
Visible remote indication for detectors concealed.
Auxiliary contact.
Label detector and bases with address number.
End of line device mounted in sensor or control panel.

4030T HEAT DETECTORS:
Type : Microprocessor based, monitored.

Manufacturer and reference
Gent 34710
Or approved equivalent
Point type
  Standard
    BS 5445 Part 5.
    BS 5445 Part 8.
Heat-sensitive element
  Rate-of-rise of temperature and fixed temperature element.
Temperature setting
  60°C.
Accessories
  Fit line monitor device.

4040T SMOKE DETECTORS:
Type : Optical Microprocessor based, monitored.

Manufacturer and reference
Gent 34710.
Or approved equivalent
Detector type
  Ionisation.
Point type.
  Standard
    BS 5445 Part 7.
    BS 5446 Part 1.
Sensitivity
Normal.

Accessories
- Line monitor device.
- Anti-insect screens.
- Anti-thunder fly fin structure.

4070T SOUNDERS:
Type: Microprocessor based, monitored.

Manufacturer and reference
- Gent 34202 + base
- Or approved equivalent

Sounder types
- Electronic sounder.

Sounder characteristics
- d.c.
- Colour: Fire red.
- Finish: Weather proof.
- Internal.

4080T FIRE ALARM CONTROL AND INDICATING EQUIPMENT:
Type: Microprocessor based, analogue fully addressable.

Manufacturer and reference
- Gent Or approved equivalent

Standard

Functional requirements
- Standard functions.

Mounting
- Surface.

Power supply
- Integral.

Indication of origin of alarms
- Zone indication
  - Graded series of displays.
- Alphanumeric display
  - 32 characters.
- Printer.
- Panel mounted.
20 columns.
24 columns.
Serial port.

General
Microprocessor based
Modular software.
One man test and commissioning.
Configuration data.
  Non-volatile memory.
  Alterable memory.
  Automatic check
    24 hours.
Real time clock.
Configuration updates performed on site.
Configuration data copied on to floppy disc.
Maximum addressable points controlled by a single processor.
  200.
Remote inputs to CIE
  Evacuate.
  Silence Alarm.
  Reset.
  Alert.

System Configuration
  Capable of operating
    Addressable two state detectors.
    Multi-state addressable detectors.
    Analogue addressable detectors.
  Capacity of addressable loop
    Minimum 99 devices.
    Maximum number of fully loaded addressable two wire loops.
  Fault protection by line isolators.
    At each addressable device.
    At each addressable sensor.
  Allocation of addresses independent of physical arrangement of loops.

Interfacing
Other CIE/systems.
Standardise input/output interface for fire brigade panel.
Public address system.

Basic System Functions
Monitor status
  All devices on addressable loops.
  Short circuit and Open circuit faults.
Incorrect addressing.
Unauthorized device removal or exchange.
Pre alarm condition.
Detector contamination.
Internal connections.
Interfaces.
Chargers.
Battery.
Remote signalling.

Visual Indicator Lamps
Power on - Green.
Fire Alarm - Red.
Fault Warning - Yellow.
Disabled/Isolated - Yellow.
Fire zones - Red per zone.
Test condition - Yellow.
Output to fire alarm routing equipment - Red.
Output to fire protection equipment - Red.
Output to fault warning routing equipment - Yellow.
Flashing.

Push Button or Switch Controls
Sound Alarms/Evacuate.
Silence Alarm
Audible signal if not reset.
Silence Control Sounder.
Test Alarms.
Reset fire.
Lamp Test.
Cancel Fault Buzzer.
Keypad.
QWERTY keyboard and function keys: integral.

Zone status indicators
Alarm.
Fault.
Isolated.

Alarm Monitoring Functions
Interrogate addressable devices
Analysis of sensor output against fire algorithms to differentiate between
Fire conditions.
Pre-fire conditions.

Supervision and Fault Reporting
Faults to be reported
- Short circuit and Open circuit
  - Loops.
  - Sounder Cables.
  - MCP circuits.
  - Ancillary devices circuits.
  - Voice alarm system.
  - Repeat or Secondary indicators.
- Unconfigured device.
- Addressable device failure.
- Device not responding.
- Double address.
- Incorrectly configured device.
- Detector condition.
- Detector removed.
- Sounder condition.
- Repeater or Remote printer failure.
- Repeat or Secondary indicators fault.
- Earth fault.
- Main Power fault.
- PSU fault.
- Charger fault.
- Battery fault.
- Battery critical.
- Mains failure.
- Auxiliary PSU failure.
- Total loss of power.
- Fuse failure.
- Relay Output fault.
- System fault.
- Signalling fault.
- Scanning or interrogation failure.
- Processor failure.
- Memory check error.
- Memory configuration data loss.
- Processor failure
  - Re-initialise, record and reset.
  - Re-initialise, reset and Indicate fault.

System Management System, available at Levels as required by BS 5839
Part 4
Management Facilities
Isolate and re-connect.
  Addressable point.
  Detector zone.
  Sounder zone.
  Remote centre signalling.
Walk-test of zones to verify detectors and sounders.
Interrogate sensor
  Cleanliness.
  Condition.
Display on alphanumeric display via menu system.
  Alarm status
    Alarm log.
    First zone alarm top field.
  Loop map connections.
  Enabled and disabled sensors.
  Fire plan configuration.
  Address locations.
  Zone alarm status.
  Zone fault status.
  Clear display function for non-fire events.
Print, via menu system
  Alarm status
    Alarm log.
  Loop map connections.
  Enabled and disabled sensors.
  Fire plan configuration.
  Address locations.
  Point isolated status.
Weekly system audible and visible warning test (BS 5839: Part 1).
Memory check
  Automatic
    Cycle 7 days or less.
Site configuration updating
  Loop map connections .
  Addressable device label change.
  Address alLocation.
CIE programmable
  Executable code and mandatory data at Level 4.
  On site.
  With integral keyboard.
Communications with remote centre
  Signals
Alarm.
Fault.

**4110 ANCILLARY SERVICES:**
Make provision to open or close circuits of ancillary services by means of relay or similar device.
Services
- Actuation of fixed fire-extinguishing systems.
- Controlling ventilating systems.
Relay type
Output
- Voltfree contacts, rated: as shown on drawing.
- Monitored.
- Power from addressable loop.
Input
- From mcp.
Output
- Monitored.
- Contacts.
4150T VISIBLE ALARMS:

- Flashing.
- High power LED.
- Xenon.
- Power supply
d.c.
- Voltage 24kV

5000 WORKMANSHIP

5010 QUALITY CONTROL:
Handle, store and install equipment and components of the fire detection and alarm system in accordance with BS 5839 and the manufacturer's recommendations.
Obtain all equipment and components from a single source.
Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
Record all commissioning tests and provide the certification required by BS 5839 Part 1.
Provide manufacturers certificates of equipment design to an approved quality management system and CIE component selection.

5020 SMOKE DETECTOR INDICATORS:
Fit smoke detector indicators external to doors, where zone is divided into rooms.

5030 MANUAL CALL POINTS:
Where manual Call points are sited in zones.
- Wire into detector circuit for fire zone.
- Wire into separate circuits to conform with detector zones.

5040 RECORD DRAWINGS AND OPERATING INSTRUCTIONS:
Provide instructions on use of installation to person responsible for use of premises. Supply the user with a logbook and certificate of installation and commissioning in accordance with BS 5839 Part 1, Appendix B and D.
Provide record drawings to user for maintenance and record purposes. Show position of various items of equipment, junction boxes, etc. and sizes and routes of Cables and wires. Include wiring diagrams of junction boxes and distribution Cases.
Provide circuit diagrams of fire alarm system and its components.
5050 CABLE INSTALLATION:
Plan and install all fire detection and alarm system Cables in accordance with BS 5839 Part 1 and the Cable manufacturer's recommendations.
Run Cables point to point without tees or spurs.
Design loop load to not exceed 80% of Cable Capacity.
W51 EARTHING AND BONDING

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES

1. Earthing of all exposed conductive parts.

2. Earthing of the power supply and distribution system.

1030 SYSTEM DESCRIPTION

A TNC-S earthing system as defined in BS 7671 (The IEE Wiring Regulations) will be applied to the development. Earthing and bonding will be provided in accordance with BS 7430.

A main earth bar will be provided in each switchroom for the connection to the building structure, piped services, the switchboards and sub-panels.

A clean earth will be provided for the computer room.
PART 2 SELECTION SCHEDULES FOR REFERENCE SPECIFICATIONS

2800 EARTHING AND BONDING COMPONENTS

2801 EARTHING AND BONDING COMPONENTS:
Comply with work section Y80 general clauses and those detailed below.

2805T CONDUCTORS:
Conductors for earthing systems to BS 7430.
Reference Y80.2010C
Conductor joints
Reference Y80.2020A
Tape fixing devices
Reference Y80.2030A

2807T EARTH ELECTRODES:
Earth electrodes for system earthing.
Reference Y80.2040B
Earth electrode clamps - reference Y80.2060
Earth electrode inspection facilities
Reference Y80.2070A

2809T EQUIPOTENTIAL BONDS:
Main equipotential bonds
Reference Y80.2090A
Supplementary equipotential bonds
Reference Y80.2100A

280BT EARTHING:
Circuit protective conductors
Reference Y80.2110A
Earthing clamps - reference Y80.2120
Earth busbars
Reference Y80.2130A
Test links - reference Y80.2140
Lugs/tags - reference Y80.2150
Protective Cable terminations - reference Y80.2160
Protective conductor warning notices/labels
Reference Y80.2170
Main earth conductor - reference Y80.2180
Earth bar label - reference Y80.2190

280D WORKMANSHIP:
Clean earth distribution - reference Y80.3010
Dissimilar metals - reference Y80.3020
Tape joints
   Reference Y80.3030A
Stranded conductor joints - reference Y80.3040
Protective Cable terminations
   Reference Y80.3050A
Earth electrodes
   Reference Y80.3060A
2810 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

2811 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

GENERALLY:
Comply with work section Y81 clauses detailed below.

2813 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

SPECIFICATION:
Carry out testing and commissioning of electrical services as section

2815 TESTING AND COMMISSIONING:

- Inspection and test procedure - reference Y81.1010
- Incorporated equipment characteristics
  - Reference Y81.1020A
- Supply characteristics - reference Y81.1040
- Design information - reference Y81.1050
- Initial verification
  - Reference Y81.1060A
- Test equipment and consumables
  - Reference Y81.1070A
- Testing
  - Reference Y81.1080A
- Continuity of protective conductors
  - ac or dc - reference Y81.1090A
- Earth fault loop impedance ($Z_s$)
  - Reference Y81.1100A
- Settings and adjustments - reference Y81.1110
- Calibration - reference Y81.1160
- Certification and reporting
  - Reference Y81.1170A
- Completion certificates
  - Reference Y81.1180A
- Records - reference Y81.1190

2817 WORKMANSHIP:

- Conductive parts - reference Y81.2010
- Cables
  - LV buried Cables - references Y81.2040A
- Conduit, trunking and ducting - reference Y81.2050
PART 3 SPECIFICATION CLAUSES SPECIFIC TO W51

3000 GENERAL

3010 STANDARDS:
Carry out electrical system earthing work in accordance with BS 7671 (IEE wiring regulations), BS 7430; Electricity Supply Regulations; and Local Electricity Supply Authority Requirements.

3020 EARTHING AND BONDING SCHEDULE:
Carry out earthing and bonding installation:-
   as drawing number.

3040 EXISTING INSTALLATIONS:
Check earth continuity conductors and loop impedance values of existing installation. Report defects and elements not in accordance with BS 7671 (IEE Regulations) before connecting new or modified installations to existing supply.

3070 EXCHANGE OF INFORMATION:
Consult with the electricity supply company regarding the earthing arrangements of the installation. Construct the earthing system to the requirements of electricity supply company. Ensure any part of the earth fault current path provided by the electricity supply company or others is suitable for the operation of the earth fault protection to be installed. Obtain the agreement and permission of undertakings providing services which are to be bonded to the earthing system.

4000 PRODUCTS/MATERIALS

4010 CLEAN EARTH DISTRIBUTION:
Install clean earth distribution in double insulated Cables from earth electrodes to equipment points. Mount all busbars with insulators and separately from other earthing systems.

4020 MAIN EARTH TERMINAL:
Provide earth bar at incoming electrical service position, for each switchboard. Bond earth terminals and metallic structure of switch and control gear and plant.
Connect each earth terminal to all other earth terminals by a ring conductor sized as BS 7430 and BS 7671.
Adjacent to main LV switch panel.

Mounting
Mount earth bar on insulated supports located at 300mm centres for 25mm bar and 450mm centres for 50mm bar, giving 30mm clearance at rear of bar.

Drill clearance holes, one for each Cable plus 30% spare holes (two minimum) at 50mm minimum centres through bar for connection of Cable lugs. Ensure clearance holes are minimum necessary size to maintain adequate lug/bar contact.

**4030 MAIN EARTH TERMINAL CONNECTIONS:**
Connect main earth conductors and main equipotential bonding conductors to main earth terminals.

Terminate circuit protective conductors on switchboard earthing bar.

Terminate conductors with compression type lugs suitable for bolting direct to bar.

Extend protective conductor from incoming main Cable gland direct to main earth terminal.

Extend separate protective conductor from main earth terminal to main switch/switch panel served by incoming main Cable.

When main Cable is provided by electrical supply Company, extend separate protective conductor from Main Cable armouring gland or direct earth terminals or PME earth installed by supply Company to main earth terminal.

Bond all main equipment and plant to an earth terminal, connected to the bonding ring conductor.

**4040T SUBSTATION EARTH BAR:**
Type: solid copper bar

Location
Substation.
Main LV switch room.

Mounting
Mount earth bar on insulated supports located at 300mm centres for 25mm bar and 450mm centres for 50mm bar, giving 50mm clearance at rear of bar.

Insulators
Mount busbar on stand-off porcelain insulators securely fixed to wall.

Terminations
Connect each conductor and tape separately and allow spare holes (minimum two) for future connections.
4050 SUBSTATION MAIN EARTH BUSBAR TERMINATIONS:
Provide terminations on busbar for each Substation main earth conductor and
HV Switchgear frame earth (bare copper tape).
LV Switchgear frame earth (bare copper tape).
Transformer frame earths (bare copper tape).
Transformer neutral earths (insulated copper Cable).
LV Switchboard neutral busbars (insulated copper Cable).
Earthing conductor to minimum 2 groups of electrodes.
Future Cable/tape terminations
30% of above terminations subject to four minimum.

4060 NEUTRAL/EARTH CONNECTION:
Provide earth leakage protection system and position neutral/earth connection

4070T CLEAN EARTH BAR:
Location
Extra Low Voltage equipment.
Mounting
Mount earth bar on insulated supports located at 300mm centres for 25mm
bar and 450mm centres for 50mm bar, giving 50mm clearance at rear of
bar.
Insulators
Mount busbar on
stand-off porcelain insulators securely fixed to wall.
Terminations
Connect each conductor and tape separately and allow spare holes
(minimum two) for future connections.

4080 TRANSFORMER OR GENERATOR EARTH ELECTRODE SYSTEMS:
Provide separate electrode systems, each not exceeding 0.2 ohms resistance,
with separate main earthing conductors for each transformer or generator, and
an additional spare electrode system for test purposes. Bond all electrode
systems together using a ring conductor. Connect electrode systems to ring
conductor via links or disconnecting joints for test purposes.

4090 INSULATED ISLAND GLANDS:
On Cables to switchboards provide insulated island glands to facilitate testing.
4130T CEILING SUPPORTS:
Bond main supports to non-current metallic parts of Electrical Installation.

Conductor
Use PVC insulated copper Cable, sized :1.5mm² or as indicated.

Holes
Drill or punch holes in main supports in positions indicated to receive terminal screws.
Use holes in main supports for terminal screws.

Terminals
Connect bonding conductors to supports through holes with tinned copper Cable lugs or tags secured to support with brass screws, washers, nuts and locking device.

Connection
Connect bonding conductors to supplementary bonding conductors in Cable trunking:- using crimp type connectors or earth terminal of lighting fitting.

4140 SAFETY EARTHING:
Provide safety earthing in accordance with BS 7430, BS 6423 and BS 6626.
Integral earthing in circuit breakers .

4150T TELECOMMUNICATIONS FUNCTIONAL EARTH:
Provide functional earth in accordance with BS 6701 and BS 7430.

5000 WORKMANSHIP

5010 INSTALLATION OF EARTHING SYSTEM:
Carry out installation of earthing system in accordance with BS 7671 (IEE Regulations) and BS 7430.

5020 WORK ON SITE:
Ensure that all building works are completed and service connections are provided,
By others.

5030 QUALITY CONTROL:
Handle, store and install all equipment and components of the lightning protection system in accordance with the manufacturers recommendations and BS 7430.
BS 7671.
Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
Test and commission the system in accordance with BS 7430 and BS 7671 and as specified. Record all test measurements.

5040T MAIN AND SUPPLEMENTARY EQUIPOTENTIAL BONDING:

Bond in accordance with BS 7430 and BS 7671 to main earth terminal all extraneous conductive parts of the installation.
Ensure the following services are bonded.
- Main water pipes.
- Air ductlines.
- Chilled water pipework.
- Exposed metallic parts of building structure.
- Thermal insulation metallic cladding.
- Metallic Cable sheaths of all Cables except British Telecom.
- Lightning protection systems.
Bond with supplementary equipotential bonds to protective conductor system, all simultaneous accessible conductive.
Ensure the following areas are bonded to BS 7671 Section 601.
- Bathrooms and shower rooms.
- All other plantrooms.
Bond to non-current Carrying parts of Electrical Installation in associated spaces to BS 7671 and BS 7430.

5070 METALLIC FENCING:
Bond to earth any metallic fencing enclosing earth electrical system in accordance with BS 7430.
5080 IDENTIFICATION:
Use numbered and/or lettered plastic cable sleeves to indicate circuit numbers and phases of corresponding phase conductors. Ensure conductors are connected to earth bar in same sequence as phase and neutral conductors. Identify at substation, switchboard and building earth bars each protective, bonding and earthing conductor. Provide labels on bars adjacent to each conductor.

5090 GENERATORS:
Provide separate earth electrode system, completely independent of supply earth system where incoming supply is not derived from Consumer's own transformers. Connect star point of generator to earth electrode system as generator manufacturers recommendations and to BS 7430. Bond generator star point and metal framework to Local Electricity Supply Company earthing point.

5110 MEDIUM VOLTAGE SYSTEM EARTHING:
Install MV system earthing to BS 7430. Connect all exposed conductive parts of the system to earth via protective conductors. Provide earth fault relay to detect currents of 10% - 15% of full load current. Provide earth loop impedance path by earthing and bonding to achieve operation of the earth fault relay at this current. Ensure extraneous conductive parts of the system are in direct contact with all simultaneous accessible conductive parts, if necessary by bonding or connection to the common steelwork structure. Connect the neutral of the MV system to one point only. Use the generator or supply transformer star point. Earth neutral directly.
Use the resistor or reactor to limit fault current to not more than 1.5 times the full load current of the largest unit in the system. Ensure if direct earthing is used the earth fault current is of the order necessary to operate the protective devices and does not produce unacceptable electromagnetic stresses. For delta connected sources use an earthing transformer between the phases and earth. For multiple power sources use switchgear to ensure single point earthing under all operating conditions.
W52 LIGHTNING PROTECTION

PART 1 SYSTEM OBJECTIVES

1010 PERFORMANCE OBJECTIVES
The building will be protected against lightning strike using Faraday Cage Principle and or Prevectron System.

1020 DESIGN PARAMETERS

   BS 6651: Code of Practice for protection of structures against lightning strike.

   NF C 17-102: French Standard

   Minimum earth resistance at each pit to be no more than 5 ohms.

1030 SYSTEM DESCRIPTION

   The system will comprise of an air termination network of and down conductors. The building fabric will be utilized where possible for the air termination and down conductors.

   Earth rods will be provided with an inspection pit and test clamp.

   Provision of a lightning protection system does not protect electronic equipment within the building which should be subject to additional measures to be carried out by the user should the need arise.

   Transient over-voltage protection will be provided on the main LV panel and on sub-main boards supplying sensitive equipment such as MATV, PAS/BGM etc.
PART 2 SELECTIONS SCHEDULES FOR REFERENCE SPECIFICATIONS

2800 EARTHING AND BONDING COMPONENTS

2801 EARTHING AND BONDING COMPONENTS:
Comply with work section Y80 general clauses and those detailed below.

2805T CONDUCTORS:

- Conductors for lightning protection system, horizontal air terminations - reference Y80.2010A
- Conductors for lightning protection system, self supporting air terminations - reference Y80.2010B
- Conductors for earthing systems to BS 7430.
  - Reference Y80.2010C
- Conductor joints
  - Reference Y80.2020A
- Tape fixing devices
  - Reference Y80.2030A

2807T EARTH ELECTRODES:

- Earth electrodes for lightning protection systems.
  - Reference Y80.2040A
- Earth electrodes for system earthing.
  - Reference Y80.2040B
- Earth electrode clamps - reference Y80.2060
- Earth electrode inspection facilities
  - Reference Y80.2070A

2809T EQUIPOTENTIAL BONDS:

- Main equipotential bonds
  - Reference Y80.2090A
- Supplementary equipotential bonds
  - Reference Y80.2100A

280D WORKMANSHP:

- Clean earth distribution - reference Y80.3010
- Dissimilar metals - reference Y80.3020
- Tape joints
Reference Y80.3030A
Stranded conductor joints - reference Y80.3040
Protective Cable terminations
  Reference Y80.3050A
Earth electrodes
  Reference Y80.3060A
PART 3 SPECIFICATION CLAUSES SPECIFIC TO W52

3000 GENERAL

3010 STANDARDS:
Provide lightning protection system in accordance with BS 6651.

3020 USE OF BUILDING ELEMENTS:
Ensure that building and structural elements used as items in or bonded to the lightning protection system are designed and erected in accordance with BS 6651 as well as their appropriate constructional specification or code of practice. Ensure that all connections to building and structural elements are waterproof and corrosion protected to a degree appropriate to their exposure.

3030 LIGHTNING PROTECTION SPECIALIST:
Engage a lightning protection specialist to carry out of the lightning protection system.

3060 BONDING OF SERVICES:
Bond or isolate all metallic services in or on the structures in accordance with BS 6651 and as indicated in the Schedules and Drawings.

3070 PROTECTION OF ELECTRONIC EQUIPMENT:
Protect electronic equipment in buildings in accordance with BS 6651 Appendix C.
   Equipment transient design level (Volts)
   Transient Control level (Volts)
4000 PRODUCTS/MATERIALS

4010T TEST JOINTS:

Conductor
Form
Tape
Material
Copper.
Test and Junction Clamp.
Square.
Plate.
Screw-down.

4020 BUILDING ELEMENTS:
Use building elements as down conductors main terminations in accordance with BS 6651, with non-ferrous bonding points built as Figure 7 for reinforcing bars.
Ensure reinforcing bars are in good electrical contact by
Welding.
Multiple fortuitous contact by binding wire.

4030T LIGHTNING PROTECTION SYSTEM BONDS:

Rigid.
Flexible.
Re-bar.
Provide purpose made bonding clamp
Metal work clamp.
Rain Water down pipe bond.
Water main bond.
Re-bar earth point
Connectors to down conductor or air terminal

4050T SURGE PROTECTION DEVICES:
Standard BS 6651.
Location Category
A.
B.
C.
System exposure
Medium.
Transient performance
Mode of protection
Line - earth.

5000 WORKMANSHIP

5010 INSTALLATION:
Install the lightning protection system and its element in accordance with the manufacturers recommendations and BS 6651 and BS 7430.

5020 WORK ON SITE:
Ensure that all building works are completed and service connections are provided.

5030 QUALITY CONTROL:
Handle, store and install all equipment and components of the lightning protection system in accordance with the manufacturers recommendations and BS 6651.
BS 7430.
Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
Test and commission the system in accordance with BS 6651 and as specified.
Record all test measurements.

5040 BONDING:
Bond or isolate building structural elements and metallic services as BS 6651, including,
Steel structural frame.
Reinforcement bars in concrete.
Metallic roof coverings.
Services
Television and radio aerials and supports.
Metal flues and flue lining.
Dry risers.
Water services.
Air ductlines.
Flag-masts.
Roof level plant rooms.
Water tanks.
5060 INSTALLATION RECORDS:
Prepare system records, including the following items:
   To BS 6651.
   As installed drawings.
Hand over the system records:
   BHC through the Consultant.

5070 MAINTENANCE:
Carry out maintenance as required by BS 6651 for the defects liability period and provide proposal for continuing maintenance to Building owner.
1000 SYSTEM DETAILS

1010 PERFORMANCE OBJECTIVES:

The BMS system shall be IP-based from which a system of sensor circuits shall emanate to building services equipment to services and equipment to be monitored and controlled.

The sensors will send signals back to the system display unit located in the Main Engineering Office with a back-up display unit in the security room.

The system shall be of the open protocol type (BACNET, LONWORK etc). It is to be noted that design and installation of the BMS is a specialized field. As such, we believe that the Bank would be engaging the services of a Specialist with whom we shall fully develop the system.

1020 DESIGN PARAMETERS:

The sensors attached to each controller will depend on the plant item and the parameters being monitored and/or controlled. The items below are examples only:

1. **Generators**
   - A multifunction meter complete with air-cored current transformers to monitor load consumption and load imbalance.
   - A flue gas temperature sensor complete with a 230mm probe, compression fitting and duct mounting flange will monitor engine temperature. The probe temperature range will be 0°C to 400°C.
   - Differential level switches will monitor the diesel storage tank fuel supply, initiating alarm signals once a predetermined 'low-level' is reached.

2. **Chillers**
   - Electronic relays will be used to trigger a signal to the digital input port of BMS controllers to monitor power supply status and initiate alarm signals in the event of power supply failure or circuit breaker trip-off.
Immersion thermistor sensors complete with a 150mm probe will monitor chilled water temperature. The probe temperature range will be from -10°C to 60°C.

Liquid differential pressure sensors will monitor chiller pumps to indicate chilled water pressure.
3. **Air Handling Units.**

   - Electronic relays will be used to trigger a signal to the digital input port of BMS controllers to monitor power supply status and initiate alarm signals in the event power supply failure or circuit breaker trip-off.

   - Differential pressure sensors will monitor pressure drop across AHU filters to indicate pressure loss due dirt accumulation.

   - Smoke detectors to be mounted in the intake duct.

4. **UPS Equipment.**

   - A multifunction meter complete with air-cored current transformers to monitor load consumption and load imbalance.

   - Electronic relays will be used to trigger a signal to the digital input port of BMS controllers to monitor power supply status and initiate alarm signals in the event of power supply failure or circuit breaker trip-off.

5. **Fire Alarm Panel.**

   - Auxiliary relays on alarm panel will be used to trigger a signal to the BMS controller to initiate alarm indications in the event fire.

   - A DC power sensor will monitor fire alarm panel battery power status and initiate alarm signals whenever the voltage input falls below a preset value.
1030 SYSTEM DESCRIPTION:

The basic network shall comprise a wired loop of:

- A local area network with multiple sensor input capabilities, an output port for a visual display unit and electronic relays to activate audible alarms.

- For each monitored plant item is deployed a controller with capacity for multiple universal inputs and one digital input. These can either be mounted centrally, that is located within the ‘supervisor’ rack or be mounted remote – located in the monitored equipment’s plant-room.

- Appropriate sensors, wired from the controllers are mounted on individual plant items or the monitored environment

To minimize BMS cabling to network loop requirements only, we prefer mounting individual controllers in plant-rooms or on a floor base, whereby sensor cabling is not subjected to unmanageable long runs.

The network shall be upgradeable

Under normal circumstances, the BMS system will be configured to display equipment status at the prompting of supervisory staff with a click on the equipment icon.

Fault conditions within any monitored system will activate automatic status display and audible alarm as necessary.

1040 CONTROL REQUIREMENTS:

- Dead bands
  Configure the thermal conditioning control system to allow for a temperature dead band of at least 4°C in order to reduce the risk of heating and cooling simultaneously and to reduce energy consumption.

- Please refer to the matrix in the Design Report for the controls.
2000 GENERAL

2010 SYSTEM REQUIREMENTS:
Select control components and equipment, suitable to meet system objective requirements. Ensure that system safety complies with BS EN 954-1.
- Where necessary comply with BS EN 61508
- Comply with BS EN ISO 16484-2.

2020 CONTROL SYSTEM:
Provide a building management system (BMS) to meet the particular requirements detailed in 1000.
- Type
- Application
- Provide a building management system, including equipment design:
  - development of design.
  - supply.
  - installation.
  - commissioning.
  - setting to work.
  - operator training
  - maintenance contract

2030 CONTROLS SPECIALIST:
Use a controls specialist to design, supply, install, test and commission complete controls installation.
- Use
- Or approved equivalent.

2140 ELECTRICAL SAFETY:
Ensure that the BMS complies with the following EC Directives
- Construction Products Directive 89/106/EEC.
- General Product Safety Directive 92/59/EEC.
Ensure that the BMS installation complies with BS 7671 Electrical Installations in Buildings.
Ensure that control panels comply with BS EN 60439-1 Low-voltage Switchgear and Control Assemblies.

AfDB: Electrical Specifications
2150 ELECTRICAL SUPPLY:

Ensure that the BMS can operate when supplied with electricity conforming to BS EN 50160 - Voltage characteristics of electricity supplied by public distribution systems.

2160 EMC:

Ensure that the BMS complies with the Electromagnetic Compatibility (EMC) Directive (89/336/EEC).
Ensure that the BMS complies with BS EN 61000-6-3 Generic emission standard, BS EN 61000-6-1 and BS EN 61000-6-2 Generic immunity standard.
Ensure that the BMS meets the EMC requirements of prEN 13646.

2170 GENERAL REQUIREMENTS - EMERGENCY RESTORATION PROCEDURES:

• Application
  • Ensure that the BMS fully restores all control and monitoring functions following an emergency shut down period.
• Strategy for phased restoration of plant operation
• Time period for restoration of plant
• Ensure that the start delay times can be adjusted according to the magnitude of the load.

2180 UNINTERRUPTIBLE POWER SUPPLY FACILITY:

• Uninterruptible power supply facility requirements
• As work section V32.

2190 TIME SYNCHRONISATION:

• Ensure that all time-dependent BMS components are time synchronised via the operator workstation.
• Ensure that the BMS can automatically change between British Summer Time (BST) and Greenwich Mean Time (GMT).
• Ensure that the BMS can accommodate leap years.

2200 SYSTEM SECURITY:

• Application
  • Provide, as a minimum, password-protected operator access for the following Levels:
    o Level 1 - Ability to display all point data.
    o Level 2 - Ability to display all point data and to initiate data logging functions.
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- Level 3 - Ability to display all point data; to initiate data logging functions; and to change set points and time schedules.
- Level 4 - Ability to display all point data; to initiate data logging functions; to change set points and time schedules; and to change control strategies and schematic/graphics functions and password assignment.

- Ensure that password-protected operator access is set up for both operator workstations and field controllers which have an operator interface.
- Ensure that passwords permit at least 6 alpha/numeric characteristics.
- Ensure that the BMS software is protected from unauthorised entry.
- Ensure that the BMS, and its operation performed under any maintenance contract, complies with BS ISO/IEC 27001 and BS ISO/IEC 17799 Code of practice for information security management.

2210 SYSTEM SOFTWARE:

- Ensure that IT industry standard operating systems are used.
- Ensure that copies of all BMS vendor-specific software are held by an independent third party and that this software can be released to the Bank.
- Ensure that the ESCROW Agreement is completed and signed.
- Ensure that licences to use software applications are owned by the Bank.
- Provide application software written in accordance with BS 7649.
- Software

2220 DESIGN FOR COMMISSIONABILITY:

- Ensure that the BMS specification details required for commissioning are made available to the Bank.
- Ensure that all field controllers, sensors and controlled devices are easily accessible and can be removed for testing and future maintenance.
- Liaise with the mechanical contractor to ensure that air handling units are provided with appropriate access doors.
- Ensure that access is available to all control devices.
- Ensure that the requirements of the following documents are met:
  - Space and Weight Allowances for Building Services Plant – Inception stage Design. TN 9/92. BSRIA
  - Space Allowances for Building Services Distribution Systems – Detail Design Stage. TN 10/92. BSRIA
- Ensure that sensors are installed correctly in order to give representative readings.
- Ensure that reference labels are attached to each control device.
2230 FUTURE SYSTEM EXPANSION:
Ensure that the BMS is capable of dealing with a future 20% increase in the number of points without compromising the system’s functionality or speed of operation.

2240 DESIGN FOR MAINTAINABILITY:
- Ensure that a full O&M manual is prepared which reflects any system changes made during the installation and commissioning stages.
- Ensure that adequate access to BMS equipment and components is provided.
- Ensure that all components and wiring are identified by a consistent numbering system.

2250 SYSTEM SUPPORT:
Ensure that a viable strategy is in place to fully support the BMS for a minimum of 10 years from the date of practical completion.

2260 SYSTEM MAINTENANCE:
Provide maintenance support for years in accordance with BSRIA BG 4/03 - BMS Maintenance Guide.

2270 INTEGRATION:
- Type
- Application
- Provide integration with specified system
- Provide specified integration functionality
- Comply with BS 7807 for integration with fire and security systems
3000 OPERATOR WORKSTATION

3010 OPERATIONAL CHARACTERISTICS:

- **Application**
- Ensure that the control of plant is independent of the operator workstation.
- Ensure that no data of a control nature is transferred between field controllers via the operator workstation, i.e. data relating to control strategies.
- Ensure that the operator workstation can communicate with all addressable field controllers.
- Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the operator workstation.
- Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field controllers.
- Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the operator workstation.
- Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.
- Ensure that the operator workstation incorporates a data storage management system that warns against impending on-line storage overflow and allows for data archiving to, and retrieval from, off-line non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.
- Ensure that it is possible to perform a complete backup of the operator workstation comprising control strategies, set-points and logged data.
- Provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data). Note that the use of multiple 3.5 inch disks is not acceptable.
- Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.
- Ensure that the backup data can be fully re-loaded.
- Ensure that selected files from the backup data can be re-loaded.

3020 WORKSTATION EQUIPMENT:

- **Type**
- **Application**
- **Manufacturer and reference**
- Or approved equivalent

  Standard BS EN ISO 16484-2
• Workstation
• Personal computer
• Hard disc storage capacity
• RAM
• Processor
• Ensure that the processor speed of the operator workstation meets the data processing requirements.
• Ensure that the processor speed is such that delays in processing system data do not exceed
• Monitor
• Use a colour monitor with a resolution no less than
• Diagonal dimension of the monitor
• Protection against reflection
• User access
• Provide a QWERTY keyboard with full upper/lower case ASCII key-set, numeric keys and mouse.
• Incorporate a touch-screen facility.
• Light pen
• Trackball
• Mouse
• Printer
• Ensure that the printer can print all monitored and logged data (including graphs of logged data); all point data (hard and soft); control logic diagrams and plant/building; schematics in colour; alarm data/text; and system help text.
• Ensure that the automatic printing of alarm data can be switched on/off.
• Ensure that the printer has a minimum output of four pages per minute.
• Paper type (sheet, continuous)

3030 MONITORING AND LOGGING FUNCTIONS:

• Application
• Ensure that all monitored point data can be displayed at the operator workstation. Ensure that analogue, digital and soft-points can be displayed simultaneously.
• Ensure that all changes made by the operator (eg set-point changes) can be logged and identified by both operator and date/time stamp.
• Provide a facility to allow the display, at the operator workstation, of 'real time' data superimposed on plant schematics with a refresh rate not exceeding 20 seconds.
• Ensure that a minimum of four 'real time' data points can be displayed simultaneously, in the form of data plots, with a time delay not exceeding 20 seconds.
• Provide a facility to allow the monitoring and display, on the same 'page', of common criteria/plant functions.
• Ensure that any hard or soft-point log can be displayed and stored on the operator workstation.
• Ensure that logs can be set up from the operator workstation and that logging times and logging intervals are user adjustable between 1 second and 24 hours.
• Ensure that the operator workstation has sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.
• Amount of logged data
• Provide a facility to allow the simultaneous display of different logged data. Ensure that this function is operator adjustable.
• Provide a facility to allow the export of logged data to other software packages. Ensure that the format of the exported data can be fully defined.
• Requirements

3040 GRAPHICAL OPERATOR INTERFACES:
• Application
• Provide graphics as
• Provide a software library of plant schematics and symbols, the format/contents of which should be confirmed with the specifier based on samples.
• Provide a facility to allow the operator to generate additional schematics and symbols.
• Ensure that the system can accommodate the addition of 20% extra graphics 'pages'.
• Provide a facility to allow the operator to modify plant schematics and to generate new ones.
• Ensure that graphics can be displayed in a layered approach (building layout graphics down to plant subsystems and components). Ensure that the operator can modify the structure of the layered approach.

3050 HELP AND ASSISTANCE:
• Application
• Provide a facility to allow the display of help text covering all operator functions and system fault conditions.
• Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy logic schematics.
3060 INTEGRATION WITH THIRD PARTY MANAGEMENT SOFTWARE:

- **Application**
  - Energy monitoring and targeting software
  - Provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BMS to the monitoring and targeting software. Ensure that the format of the exported data can be fully defined.
- **Requirements**
  - Maintenance management software
  - Provide a facility to allow the direct transfer between the BMS and the maintenance management software of plant run hours; number and frequency of plant starts; critical alarms requiring immediate attention; and maintenance (non-critical) alarms.
  - Ensure that the format of the exported data can be fully defined.

3070 SYSTEM ALARMS:

- **Application**
  - Ensure that alarms are displayed on a rolling basis in chronological order.
  - Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators.
  - Provide a facility to silence audible alarms or inhibit flashing annunciators without performing alarm acknowledgement.
  - Ensure that alarms can be inhibited for reasons of time and/or priority as selected by the operator.
  - Ensure that the BMS can be configured to avoid fleeting alarms, i.e. ensure that alarms can accommodate start-up and shutdown delays.
  - Ensure that the operator can alter the limits at which the measured values cause alarms to be triggered.
  - Ensure that alarms can be limited to the source items(s) of plant.
  - Ensure that alarm limits can accommodate sliding limits, e.g. set-point changes.
  - Ensure that alarms can be differentiated by means of alarm type and identification.
  - Ensure that alarms can be prioritised (including a high priority that will be annunciated regardless of other activity) and a low priority or information status that is only annunciated on demand.
  - Ensure that the time taken to receive alarms does not exceed
  - Ensure that visual, audible and printed annunciation of alarms, or any combination of these, can be selected by the operator.
  - Ensure that the reception and acknowledgement of alarms can take precedence over other operations. However, ensure that the reception of alarms does not hinder user log-in.
  - Allow the user to acknowledge alarms individually and on a group basis.
Acknowledgement should include muting or flashing annunciators.

- Provide distinction between active alarms whose conditions are not cleared and unacknowledged alarms.
- Provide an alarm-latching facility with manual reset.
- Ensure that alarm data provides condition identity; condition value; alarm source; alarm time and date; and acknowledgement status.
- Ensure that the alarm file can be sorted by the above criteria.
- Allow alarms to be automatically redirected to other user interfaces.
- Provide sufficient data storage capability for the storage of alarms.
- Ensure that any stored alarm data can be analysed in conjunction with other monitored conditions or stored logged data.
- Ensure that an alarm review facility is available.
- Allow the display of stored alarm data based on user definable selection criteria.
- Ensure that the operator can define the requirement for acknowledgement of alarms; a time programme for annunciation of alarms to different destinations; and text messages associated with alarm conditions.
400.000 FIELD CONTROLLERS

4005 CONTROLLERS:
- Standard BS EN ISO 16484-2
- Mounting
- In control panel.
- Casing material
- Rigid plastic.
- Rigid plastic with die cast aluminium finish.
- Control functions
  Comply with requirements of W60.600.000

4010 MODES OF OPERATION:
- Application
  Ensure that the field controllers perform all control actions independently of the operator workstation.
  Ensure that all field controllers can operate independently and in real time following a failure of the BMS communication network.
  Ensure that field controllers can operate with the loss of shared data through the use of default values and final data reading before the loss of network communications.
- Provide operator interfaces

4020 PHYSICAL CONSTRUCTION:
- Application
  For internal plant room applications, construct field controller enclosures to give a minimum degree of protection to IP54 in accordance with BS EN 60529. Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41. For external applications, construct field controller enclosures to IP65.
  Where an enclosure is to be provided ensure that field controller enclosures are lockable.
  Ensure that modular construction is used for field controllers. Ensure that this allows the removal and replacement of devices without the need for rewiring of field wiring.

4030 TERMINATIONS:
- Use terminals of the screw down clamp-type fixed to purpose made mountings.
- Segregate into groups terminals carrying different voltages (in accordance with BS 7671).
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4040 FUTURE EXPANSION:
Make provision for a future 20% increase.

4050 CONTROLLER INPUTS:

- Application
- Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices. Ensure that the following requirements are met.
- Analogue input
- Variable currents (4-20 mA), variable voltages (0-10V) or variable resistances.
- Ensure that the routines necessary to process analogue inputs are resident at the field controller.
- Ensure that a minimum and maximum limit value can be defined for each analogue input. Ensure that each limit is associated with a configured response.
- Ensure that the field controller can detect open or closed circuit faults and raise an alarm on the operator workstation.
- Ensure that non-linear inputs can be calibrated/scaled.
- Ensure that it is possible to define a relationship between an analogue point threshold value and a digital point status.
- Digital inputs
- As derived from volt-free contacts (max 24 volts/20mA). Allow the interface to be selected to monitor a normally open or normally closed circuit.
- Ensure that the routines necessary to process the digital inputs are resident at the field controller.
- Pulsed inputs
- As derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 32Hz.
- Ensure that the routines necessary to process pulsed inputs are resident at the field controller.
- Ensure that the field controller has the following capabilities.
- Storage of cumulative totals daily; weekly; monthly; yearly; and continuously.
- Operator re-set facility of cumulative totals via the operator workstation.
- Facility to combine counts from separate pulsed inputs.
- Ability to calculate the number of pulses per unit time through addition and/or subtraction.
- Ability to compare the number of pulses with preset limits on the basis of total number of pulses per unit time and the time required for a total number of pulses.
- Ability to convert pulsed readings into quantifiable values.
- Alarm facility based on a user-defined limit being exceeded.
- Ensure that the inputs which are used to monitor fluctuating pulse rate (e.g. maximum demand meter for electricity) have operator adjustable limits.
- Ensure that when data for pulsed inputs is recorded, the record includes both the pulse count and logging intervals for cumulative counts.
Run-time totals
• Include run-time totalling routines to enable the operator to record cumulative run-time for each item of plant selected.
• Provide the operator with the option to set a different maximum run-time for each item of plant selected.
• Ensure that when the maximum run-time has been reached an alarm is signalled to the operator.
• Ensure that the operator workstation can be used to interrogate field controllers for a point-by-point summary of run-time totals and run-time limits.
• Ensure that it is possible for the user to set an initial value of hours run other than zero.

General
• Ensure that all inputs can be scanned at intervals not exceeding 1 second.
• For time-critical control applications, ensure that the field controller can scan at a time interval not exceeding
• Ensure that all inputs are protected against spurious out-of-range signals including those caused by contact noise or bounce.
• Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 0.1% of the analogue value.

4060 CONTROLLER OUTPUTS:
• Application
• Ensure that isolation between controllers and networks meet the requirements of EN 13646.
• Ensure that the field controllers’ interfaces are capable of providing control signals to actuators and switching devices.
• Ensure that routines are configurable, such that one or more events may be enabled in direct response to any defined logical relationship between the status of a number of physical or soft-points.
• Ensure that in the event of power failure, output devices can be driven to their preset, fully open/closed position.
• Provide the following interface characteristics:
• Analogue output. As variable currents (4-20mA) or as variable voltages (0-10V). Ensure that it is possible to characterise analogue outputs in order to obtain a near linear response from the controlled items of plant.
• Digital output. Ensure that digital outputs can be selected as 'normally closed' or 'normally open'.
• Ensure that errors introduced by the digital to analogue conversion of outputs do not exceed 0.1% of the digital value.
• Ensure that the field controller is capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.
4070 POSITIVE FEEDBACK:

- Application
- Ensure that the field controllers can include routines necessary to confirm that specific items of plant are functioning correctly. Ensure that this can be performed by monitoring physically separate but functionally related sensors, switches or transducers.
- Ensure that an alarm is raised if the expected response has not been established by a pre-set time following switching on of plant. Ensure that it is possible to operate any specified standby plant. Provide the operator with a facility to adjust the pre-set time delay.
- Ensure that the field controllers are capable of using measured feedback from an actuator position to give a percentage open reading.

4080 DATA MONITORING AND LOGGING:

- Application
- Ensure that hard and soft-points associated with a field controller can be logged.
- Ensure that the BMS operator can set the start/stop times and logging frequency at the operator workstation.
- Ensure that logging is selectable between fixed periods or on a rolling basis.
- Ensure that each log can be defined in terms of log identification (point identification); units; and date/time stamp.
- Ensure that the operator can select all physical and soft-points for logging.
- Ensure that the field controller has sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points on the field controller.
- Ensure that when the logging capacity of a field controller is exceeded, the data can be automatically downloaded to the operator workstation and archived.

4090 ENVIRONMENTAL CONDITIONS:

- Application
- Ensure that field controllers are suitable for operating normally within the following environmental ranges:
  - Temperature 0 to 50°C
  - Relative humidity 10% to 90% non-condensing.
- Ensure that the field controllers will operate in the electrical environment associated with building services plant rooms.
- Ensure that the EMC requirements specified in W60.210.060 are met.
- Ensure that the field controllers are protected against the effects of moisture, dust, dirt and gases.
4010 INTERNAL POWER BACKUP:
- Application
- Provide internal power backup
- Ensure that a rechargeable battery or capacitor, if specified, can hold the controller's volatile memory for a minimum period of 72 hours.
- Ensure that a non-rechargeable battery, if specified, can maintain the controller's clock function for a period of two years.
- Ensure that the battery is easily replaceable.
- Ensure that the interval between battery maintenance inspections is not less than 12 months.
- Ensure that any battery monitoring functions defined in the Particular Inspection can be met.

4020 MEANS OF CONFIGURATION:
- Application
- Ensure that the field controllers can be fully configured directly via a laptop type computer and via the operator workstation.
- Ensure that the field controllers can be configured through the use of a configuration interface with full upload and download capability.
- Ensure that configuration details can be easily altered by system operators.
- Ensure that access to make configuration alterations is restricted to operators with access authority through the use of passwords.

4030 USER INTERFACES:
- Application
- Ensure that all field controllers can be accessed through the use of portable computers.
- Ensure that access allows the display of all configuration details associated with the field controller along with:
  - Password protection for access with a minimum of two access levels.
  - Ability to display all point data (both hard and soft).
  - Ability to initiate and display logged data.
  - Ability to display and alter set-points and time schedules.
  - Ability to make alterations to control strategies.
- Ensure that field controllers incorporate a panel-mounted operator interface. Ensure that the interface includes the ability to:
  - Provide password protection for access with a minimum of two access levels.
  - Display all physical point data.
  - Display and alter set-points and time schedules.
  - Display the current date and time.
  - Review and acknowledge alarms.
  - Access logged data.
4040 DEDICATE CONTROLS:

OPTIMISERS:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent.
- Standard - BS EN 12098-2.
- Function

COMPENSATORS:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent.
- Standard
  - BS EN 12098-1.
  - BS EN 12098-3
- Function

TIME SWITCHES:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent.
- Standard - BS EN 60730-2-7.

Provide time switches with minimum of 24 hours mains failure reserve facility.
5000 OCCUPANT CONTROLS

5010 GENERAL:
- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Ensure that the specified occupant controls can be linked to, and communicate over, the BMS communications network.
- Ensure that the occupant controls can control the relevant items of plant.
- Ensure that the status of each occupant controller can be viewed and overridden via the operator workstation.
- Ensure that the occupant controls allow:
  - Adjustment by the occupants of the set-points.
  - Definition, and adjustment by the BMS operator, of high and low limits for each set-point control.
- Provide a facility to allow the global alteration of set-point and high/low limits via the operator workstation.
- Provide an override facility to allow plant operation during out of hours occupation.
- Ensure that the occupant controls are intuitive to use and clearly labelled.
- For temperature control ensure that hot/cold and/or red/blue indication is used for the occupant interface.
- For fan speed control ensure that fan fast/slow indicators are used.
- Ensure the +/- symbols are not used without clarification of the controlled function.
- Wall/desk mounted
6000 CONTROL FUNCTIONS

6010 GENERAL:
Provide a facility to automatically cycle selected actuators through their full range of movement outside normal operating periods with a periodicity set by the operator (in addition to normal automatic or manual control). Ensure that the cycle finishes as one complete operation. Ensure that any alarm conditions raised during the operation are inhibited as necessary.
Provide a facility to drive actuators to their open or closed positions at the end of plant operating periods.

6020 BASIC CONTROL FUNCTIONS:
- Application
- Ensure that configuration routines necessary for direct digital control (DDC) are resident at the field controllers.
- Provide DDC of plant through algorithms giving proportional plus integral plus derivative control (PID).
- Provide two-position control.
- Provide raise-lower or three-point control.
- Allow the selection of either proportional control (P) or proportional and integral control (P+I) or proportional and integral plus derivative control (P+I+D) modes independently for each relevant item of plant. Ensure that proportional, integral and derivative action times can be adjusted by the user.
- Allow the combination of more than one control loop by 'cascading', i.e. using the output signal from one control loop as the input signal to another control loop.
- Ensure that the control routines are capable of controlling the individual plant items listed
- Provide logic modules covering
  - Logical combination of digital variables.
  - Logic timer module.
  - Logic readback module.
  - Logic counter module.
  - Logic delay module.
  - Logic hours run module.
- Provide the following logic functions:
  - AND.
  - NOT AND (NAND).
  - NOT OR (NOR).
  - OR.
- Provide the following function modules as a minimum:
Filter (applies exponential filter with gain to input signal).
Rescale from (rescales an input of 0 to 100 to a user defined output and limits at these values).
Rescale to (rescales the input to the output of 0 to 100 and limits at 0 and 100).
Limit at (limits the output at user specified values).
Limit to (limits the output to 0 or 100 percent at values specified by the user).
Logarithm of input; Square root of input; Add to input; Multiply by input; Divide by input.
Minimum (to select the minimum value from two or more inputs);
Maximum (to select the maximum value from two or more inputs);
Average (to calculate the average value from two or more inputs).
Analogue gate (digital signal switches output between two analogue input signals).
Comparator (to compare two inputs, when input X is greater than input Y output of one is produced otherwise the output is zero).
Enthalpy (to calculate the enthalpy value from a temperature input and humidity input).
Hysteresis (changes a digital state if the input changes outside a defined band).
Analogue to digital converter (to change analogue value to binary).

6030 CONTROL INTERLOCKS:
- Application
- General
- Ensure that the BMS is capable of providing all control interlocks detailed
- Frost protection
- Provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage.
- Provide the following two stages of protection:
  - Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start and circulation is established through pipework systems and their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.
  - Ensure that when the return temperature falls below the operator pre-set minimum, the full frost-protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.
- Provide a facility to allow frost protection to be logged together with data and time.
- Building/plant protection
- Provide protection routines to operate the plant in order to protect the building fabric and its contents against the effects of low internal temperatures and of
condensation.

- Ensure that if the internal air temperature falls below the pre-set protection temperature, the heating system and related plant is turned on and heat supplied to maintain the air temperature at or above the protection set-point temperature.
- Ensure that the building/plant protection routine overrides other control functions unless otherwise specified.
- Ensure that protection operates whenever the normal heating is switched off.
- Safety interlocks
  - Ensure that all safety interlocks are hardwired and have precedence over all other control functions.
  - Ensure that safety interlocks can only be reset manually and locally (not from the operator workstation).
  - Ensure that all hardwired safety interlocks have corresponding software interlocks to prevent cascading nuisance alarms.

6040 TIME SCHEDULES:

- Application
  - Ensure that each field controller is capable of enabling plant according to multiple pre-set time programmes.
  - Ensure that it is possible to schedule each item of plant for a minimum of three separate switching periods per 24 hours.
  - Ensure that separate schedules can be defined for each day of the week.
  - Ensure that individual time schedules can be grouped to form global time schedules.
  - Ensure that time schedules can be defined on a weekly basis on a single 'page/screen'.
  - Ensure that time schedules can be defined 12 months in advance.
  - Provide a time schedule override facility to accommodate holiday periods, etc.
  - Allow fixed extensions and contractions to time schedules. Ensure that the time schedule reverts to the 'normal' switching periods following the extension/contraction period.
  - Allow time schedules to be copied from existing schedules.
  - Ensure that time schedules can be linked to optimum start/stop control facilities.
  - Provide an optimum start/stop override facility for user-defined override days.
  - Ensure that optimum start/stop control is enabled following the override period.
  - Provide automatic switching between BST and GMT and back. Provide an operator override facility.
  - Ensure that time schedules can accommodate leap years.

6050 PLANT START/STOP CONTROL:

- Application
  - Ensure that field controllers are capable of starting and stopping plant according
to the sequences detailed
• Including any specific requirements for 'off' position or status of plant items,
• valves and dampers, etc.
• Ensure that field controllers are capable of automatically enabling standby plant
  on failure of duty plant.
  Ensure that the field controllers can automatically report plant failure alarms at
  the operator workstation.
  Ensure that the failure of a flow switch or other device does not continuously
  cycle plant.
• Ensure that if a flow switch fails the operator has the option to force either the
  duty or standby plant to come on.
• Provide the operator with the option to override any start/stop action configured
  within the field controllers.
  When reverting to normal automatic control, ensure that the original program is
  automatically reinstated and updated to the correct time.
• Provide delayed plant-starting facilities in order to reduce power surges.
  Ensure that it is possible to start plant sequentially by adjusting the delay period
  for each item of plant.
• Ensure that delayed plant-starting occurs following power failure/re-instatement
  and plant shut down/restart on fire/fireman override.
• Provide the operator with a facility to specify minimum on/off cycle times and/or
  the maximum number of starts per hour for specified items of plant.
• Provide a plant protection routine that enables the operator to select and
  automatically run items of plant for short periods during out of season shut-down.
  Ensure that the run periods are operator adjustable.

6060 SEQUENCE CONTROL:
• Application
  • Provide sequence control routines to automatically sequence the operation of
    multiple items of plant by monitoring load parameters and efficiently matching the
    plant to the load.
  • Ensure that it is possible to define different automatic sequences of control.
  • Provide the operator with a facility to override the automatic sequence and define
    an alternative sequence.
  • Ensure that the set-point values for each control action are variable and
    adjustable by the operator.
    Ensure that associated alarm limits are modified automatically.
  • Allow the operator to adjust switching control differentials to prevent short cycling.
  • Ensure that the routines also include a facility to operate all plant ancillaries
    associated with sequence control unless they have been specifically excluded.
  • Ensure that the routines include the facility to proceed with the defined sequence
    when one of the items of plant in the sequence is isolated or fails to operate
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(unless the safety requirements dictate otherwise).
Ensure that failed items of plant are removed from the sequence.

6070 PLANT ROTATION CONTROL:

- Application
- Ensure that relevant field controllers are capable of alternating the lead plant items where duty and standby equipment is installed. Ensure that this is achieved both by an operator command and on a time-scheduled basis.
- Ensure that the rotation control can be provided on the basis of run hours, elapsed time and calendar basis.
- Provide routines to ensure that when the maximum number of start/stop cycles for a particular plant is reached, then its schedule is automatically modified, eg by rotating the standby equipment or changing the lead machine.
- Ensure that each item of plant operated under rotation control can operate at any stage of the rotation sequence.
  - 1-2-3.
  - 2-1-3.
  - 3-2-1.
- Ensure that the plant rotation control can accommodate a plant failure condition, in such a way that a failed item of plant is 'replaced' by the next in the rotation cycle. Ensure that an alarm condition is raised in response to plant failure.
- Ensure that rotation control can be initiated outside normal operating periods.

6080 OPTIMUM START/STOP FOR HEATING SYSTEMS:

- Application
- Provide an optimum-start routine for the heating system to compute the daily minimum pre-heat period necessary to achieve target comfort conditions at the start of occupation.
  Provide an optimum-stop routine to compute the earliest time for the heat source to be shut down in order to retain minimum target comfort conditions in the zone at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real time clock, calendar facility and time programme to define the occupation periods.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Ensure that the routines operate the heating and ventilation plant as necessary to achieve the required target conditions, and that the heating and cooling systems do not conflict in any controlled zone.
- Provide independently adjustable start and stop comfort conditions.
- Ensure that weather compensation control can be inhibited during pre-heat periods.
- Ensure that the heating plant goes into full heating mode with full re-circulation of
Ensure a return to normal fresh air control following the optimum start period.

- Provide the optimum start/stop routines with an automatic self-learning process that seeks to reduce any error in achieving the target conditions at the target time.
- Provide the operator with the facility to adjust the following parameters:
  - Target temperature for optimum start.
  - Maximum pre-heat period.
  - Target temperature for optimum stop.
  - Minimum space temperature for out-of-hours periods.
  - Enable/disable the self adaptation function.
  - The default limit time for handover to the weather compensation routines after the start of occupation.
- Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

6090 OPTIMUM START/STOP FOR COOLING SYSTEMS:

- Application
  - Provide an optimum-start routine for the cooling system to compute the daily minimum pre-cool period necessary to achieve target comfort conditions at occupation start time.
  - Provide an optimum stop routine to compute the earliest time for the cooling system to be shut down in order to retain minimum comfort conditions in the space at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real-time clock, calendar facility and time programme to define the occupation periods.
- Ensure that routines are capable of operating the ventilation system for building purging prior to optimum start of cooling plant.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Provide routines to operate chillers and ventilation plant as necessary to achieve the required target conditions while ensuring that heating and cooling systems do not conflict in any controlled zones.
- Provide the operator with the facility to adjust the following cooling system optimum start/stop parameters.
  - Target temperature for optimum start.
  - Maximum pre-cool period.
  - Earliest time for building purging during out of hours period.
  - Inside and outside temperature limits for building purging.
  - Separate time/temperature relationships for optimum start and optimum stop.
  - Minimum space temperature during building purging.
- Ensure that the internal and external air temperature sensors associated with the
optimiser are positioned correctly in order to provide representative readings.

6100 WEATHER COMPENSATION:

- Application
- Provide weather compensation routines to control the heating system in relation to external weather conditions.
  Provide the operator with the option to adjust temperature and flow-rate settings for the heating system to re-define the weather compensation.
- Provide automatic adjustment to the weather compensation by comparing measured and required space temperatures with the outside conditions, and provide the facility to correct the compensation where a significant difference between the two space temperatures occurs.
- Ensure that abrupt changes in the heating system performance or space temperature shall not adversely affect the automatic adaptive compensation process.
- Provide a single weather compensation curve for each zone irrespective of the number of temperature sensors provided in the zone.
- Ensure that the routines respond to the reset signals arranged to achieve boost, night set-back and boiler safety.
- Ensure that air temperature sensors associated with the compensator are positioned correctly in order to provide representative readings.
7000 SYSTEM COMMUNICATIONS

7010 GENERAL:
- Application
- Ensure that the system communications allows the full transfer of monitored, logged, alarm, backup and configuration data between the operator workstation and addressable field controllers.
- Ensure that the communication protocol selected seeks to achieve error-free data transfer.
  Ensure that the protocol includes an error detection check; includes an error correction and/or re-try technique; limits re-transmission; and raises an alarm condition on failure.
- Ensure that the available bandwidth is sufficient to avoid excessive delays in transmitting data. Ensure that the maximum permissible time delay does not exceed

7020 COMMUNICATION DEVICES AND LINKS:
- Type Application
- Manufacturer and reference
- Or approved equivalent
- Ensure that the speed of modems complies with
- Ensure that connections to telecommunication systems complies with BS 6701.
- Provide an ISDN link.
- Provide a broadband link
- TCP/IP
- OPC
- HTML

7030 COMMUNICATIONS PROTOCOLS:
- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- BS EN ISO 16484-5
- BS EN 61030
- BS EN 61158-2
- Modbus
- Batibus
- EI bus
- Lontalk
- Proprietary
Field-level protocols
Ensure that the selected protocol can:
Run on the required communications media.
Provide a communications throughput sufficient for the intended application.
Provide appropriate network topology options.
Allow sufficient maximum physical segment length.
Allow sufficient maximum number of nodes for each physical segment and the logical network.
Provide sufficient maximum distance between nodes.
Make use of off-the-shelf network devices such as repeaters, bridges and routers.
Allow control devices to be powered from the network.
Ensure that the protocol is compatible with fully developed network configuration and management tools.

7040 DIRECT INTEROPERABILITY:
Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.
Ensure that each of the protocol's arrangements for physical connection, data packaging, network management and error detection/correction are the same.

7050 GATEWAYS:
Type
Application
Manufacturer and reference
Or approved equivalent
Ensure that the gateway can:
Transfer the specified maximum number of points
Limit loss of functionality to the level specified
Add functionality where specified
Limit any time delay across the gateway to the maximum
Ensure that the specified contingency and alarm measures in response to a failure of the gateway are met.
Ensure that the gateway can be modified in response to any future changes relating to the type and amount of data transferred over it.
Clearly define who has contractual responsibility for the implementation of the gateway.
7060 COMMUNICATION NETWORKS:

- Application
- Ensure that all addressable control devices can be addressed over the communications network.
- Ensure that the bandwidth and subsequent speed of communications is sufficient to meet the requirements of
- Ensure that no cross corruption of data occurs when the BMS shares a communication network with other IT-based systems. Ensure that permission has been given by the IT manager to connect BMS components onto the IT network.
- Ensure that network testing, identification and documentation comply with BS EN 50174.
- Ensure that all network devices such as routers and bridges are compatible with the network and are capable of operating such that the required throughput of data is achieved.
8000 SENSORS AND SWITCHES

8010 GENERAL:

Interface sensors with controllers and indicators via amplifiers or transmitters, where necessary.
Ensure that all signals are compatible with interfaces fitted to associated field control devices.
Ensure that the performance of the sensors and detectors are not adversely affected by the following variations in power supply conditions: 230V+10%, -6%.
Ensure that connections to sensors and detectors are of a screw down clamp type or self-locking connectors.
Ensure that sensors, detectors and meters are installed in accordance with the manufacturer's instructions and recommendations.
Ensure that calibration conditions for meters are fully documented in the O&M manuals and clearly marked on or adjacent to the meters.
Ensure that any calibration and maintenance requirements for sensors, detectors and meters are documented in the O&M manuals.

8020 TEMPERATURE SENSORS:

- Type
- Application
- Manufacturer and reference
- Or approved equivalent
- Standard
- BS EN 60730-2-9.
- Use thermocouple assemblies consisting of element, sleeve and connector.
- Connect thermocouple assemblies to
  - a digital indicator/control unit.
  - an analogue indicator/control unit.
- Method
- Directly.
- Indirectly.
- Sensor
- Enthalpy.
- Ductline.
- Surface.
- Room.
- Immersion.
- Outside air.
- Indicator
Provide indicator capable of showing measured value at sensor. Calibrate indicators
- Time constant
- Space/outside air temperature - 300s still air
- Duct air temperature - 120s @ 1 m/s
- Water - 30s @ 1 m/s

Ensure that temperature sensors comply with the minimum requirements of the following table.

Table 1  Temperature sensors - minimum requirements
<table>
<thead>
<tr>
<th>Fluid</th>
<th>Temperature range °C</th>
<th>Sensor accuracy °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>-10 to + 40</td>
<td>+/- 0.5</td>
</tr>
<tr>
<td>Flue gas</td>
<td>+30 to + 850</td>
<td>+/- 3.0 (0.75% of FSD above 450°C)</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>-10 to + 30</td>
<td>+/- 0.25</td>
</tr>
<tr>
<td>Water</td>
<td>-10 to +150</td>
<td>+/- 0.5</td>
</tr>
</tbody>
</table>

**8030 HUMIDITY SENSORS:**
- Measurement
- Relative humidity.
- Absolute humidity.
- Indicator
  - Provide indicator capable of showing measured value at sensor. Calibrate indicators
- Time constant - 300s @ 1 m/s

Ensure that humidity sensors comply with the minimum requirements of the following table.

Table 2  Humidity sensors - minimum requirements
<table>
<thead>
<tr>
<th>Sensor</th>
<th>Humidity range</th>
<th>Sensor accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td>10 to 90%</td>
<td>+/- 5% RH</td>
</tr>
</tbody>
</table>

**8040 AIR VELOCITY SENSORS:**
- Method
- Pitot static tube
- Thermo-electric anemometer

Ensure that air velocity sensors comply with the minimum requirement of the following table.

Table 3  Air velocity sensors - minimum requirements
<table>
<thead>
<tr>
<th>Sensor</th>
<th>Sensor range</th>
<th>Sensor accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pitot static</td>
<td>3 to 80 m/s</td>
<td>+/- 2% of reading</td>
</tr>
<tr>
<td>Thermo-electric anemometer</td>
<td>0 to 20 m/s</td>
<td>+/- 3% of reading or +/- 0.1 m/s whichever is greatest</td>
</tr>
</tbody>
</table>
8050 AIR PRESSURE SENSORS:
- Use pressure transducers manufactured in stainless steel.
- Voltage output
- Accuracy
- Connect pressure transducers, via matched transmitters to
  - single way display/alarm/control unit.
  - multi-way display/alarm/control unit.
- Indicator
  Provide indicator capable of showing measured value at sensor. Calibrate indicators
Ensure that air pressure sensors comply with the minimum requirements of the following table.
Table 4   Air pressure sensors - minimum requirements
<table>
<thead>
<tr>
<th>Sensor</th>
<th>Sensor range</th>
<th>Sensor accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pressure</td>
<td>-</td>
<td>+/- 2% of reading</td>
</tr>
</tbody>
</table>

8055 FLOW SENSORS:
- Standard - BS EN 60730-2-18.
- Provide flow detectors and connect to display/alarm/control unit
- Sensor
  - Venturi.
  - Differential pressure transducer.
  - Electro-magnetic meter.
  - Computed mass flow.
  - Turbine flow.
  - Oscillating vane.
  - Paddle wheel.
  - Nozzle.
  - Magnetic flow.
  - Vortex.
- Sensor range
- Sensor accuracy
- Time constant 5 seconds
- Indicator

8060 FLOW METERS:
Ensure that meters comply with the minimum requirements of the following table.
Table 5   Flow meters - minimum requirements
<table>
<thead>
<tr>
<th>Meter</th>
<th>Meter range</th>
<th>Meter accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel flow meter</td>
<td>0 to 10 Hz</td>
<td>3% of reading</td>
</tr>
<tr>
<td>Water flow meter</td>
<td>&gt;&gt; 5:1</td>
<td>2% of reading</td>
</tr>
<tr>
<td>Electricity meter</td>
<td>-</td>
<td>1.5% of reading</td>
</tr>
</tbody>
</table>
8065 LEVEL SENSORS:
- Provide liquid level detectors and connect, via matched amplifiers, to
  - single way display/alarm/control units.
  - multi-way display/alarm/control units.
- Sensor
  - Use capacitance electrodes manufactured from stainless steel and with PTFE insulation for use on conductive liquids with a minimum conductivity of 0.01 S/m.
  - Use conductivity electrodes manufactured from stainless steel, either single or multi-tipped.
  - Float type to BS EN 60730-2-16.
- Indicator
  Provide indicator capable of showing measured value at sensor. Calibrate indicators

8070 OTHER SENSORS:
- Type
  - Smoke.
  - Specific gravity.
  - Quantity.
  - CO₂.
  - CO.
  - BS EN 50291.
  - BS EN 50292
  - Combustible gases and oxygen
  - BS EN 50271
  - Turbidity.
  - Flame ignition failure.
- Sensor range
- Sensor accuracy
- Time constant
- Indicator
  Provide indicator capable of showing measured value at sensor. Calibrate indicator

8075 TRANSMITTERS:
- Use transmitters to interface between sensor and controller, utilizing only one sensor.
- Use transmitters capable of connection to the number of controllers
- Input
  - Input span
  - Zero offset
  - DC
  - AC
  - True rms
• Voltage
• Current
• Frequency
• Pulse rate
• On/off.
• Resistance
• RTD to BS 1041-3
• RTD to BS EN 60751.
• Thermocouple BS EN 60584 type
• Strain gauge
• Lead resistance
• Bandwidth
• Bias current
• Input resistance

• Output
  • + or - 1 V
  • + or - 2 V
  • 0 - 5 V dc.
  • 0 - 10 V dc.
  • 0 - 1 mA.
  • 4 - 20 mA.
  • 10 - 50 mA.
  • Source.
  • Sink.
  • Compliance
  • 2 wire.
  • 4 wire.

• Local control outputs
  • Number of set points
  • Value of set point
  • Relay contact rating
  • Proportional output
  • BCD

• Local display
  • LED
  • LCD
  • Number and type of digits
  • A/D conversion
  • Signal integration
  • Sampling rate
  • Analogue
28/05/13

W69 BUILDING MANAGEMENT SYSTEM

- Characteristics
  - Common mode noise rejection
  - Normal mode noise rejection
  - Common mode voltage protection
  - Normal mode voltage protection
  - Reverse polarity output protection
  - Open lead indication
  - Step response time
  - Repeatability error
  - Stability
  - Temperature error
  - Power supply error
  - Operating temperature range
  - Operating humidity range
  - Degree of enclosure protection to BS EN 60529
  - Case material
  - Dimensions
  - Weight
  - Input connections
  - Output connections
  - Mounting
  - Power supply

8076 AMPLIFIERS:
Use amplifiers to increase/change a signal from a sensor.

8077 TRANSDUCERS:
- Use transducers to receive 0-20V DC signal from controller and to convert it to proportional 0-15 psi output. When using transducers use electromagnetic actuators.
  - Transducer
    - Electro-pneumatic.
    - Electro-hydraulic.

8080 AIR DIFFERENTIAL PRESSURE SWITCHES:
- Adjustment range for trip pressure
- Maximum operating pressure
- Electrical rating
- Ambient temperature limits
- Reset differential
- Maximum differential pressure overload
8090 AIR THERMOSTATS - ROOM TYPE:
- Standard
- BS EN 60730-2-9.
- Position
- Wall mounted.
- Ancillaries
- Built in set point potentiometers.
- Heat anticipators.
- Night set-back.
- Range inserts, when using thermostats in series.
- Fixed set points.
- Tamper-proof cover.
- Remote set point adjustment.
- Time switch.
- Controller.
- Reverse Action.
- Combined humidistat.

8095 AIR SENSOR - INSERTION TYPE:
- Use proportional type insertion sensor.
- Sensor
- Averaging type temperature sensor for mounting overface of air flow in an air-handling unit or in ductwork adjacent to a heating coil.
- Thermistor type temperature sensor, minimum stem length 200mm for mounting in the air flow or distribution ductlines.

8100 AIR THERMOSTATS - SURFACE TYPE:
- Standard
  - BS EN 60730-2-9.
Use surface type thermostats on
- pipelines.
- windows.

8105 AIR THERMOSTATS - MULTI-STEP TYPE:
- Application
  - Steps

8110 AIR THERMOSTATS - MASTER TYPE:
- Application
  - Provide master type thermostats to measure conditions at one point and reset the point of another (sub-master) thermostat or controller.
8115 AIR THERMOSTATS - REMOTE BULB TYPE:
- Connect via
  - cable.
  - capillary.
- Ancillaries
  - Clamp-on detector for pipelines.
  - Solar collector detector.
  - Immersion detector and pocket.
  - Insertion detector.

8120 AIR THERMOSTATS - FROST PROTECTION TYPE:
- Standard
  - BS EN 60730-2-9.
- For space mounting use frost protection thermostats with temperature range of 0-20°C and with SPST switching action and electrical rating of 20 amps resistive.
- For heater battery protection use frost protection thermostats consisting of a gas filled sensing element and a bulb, a directly adjustable set point and switching differential.
- For compensated systems use external frost type thermostats with proportional type sensor, the whole unit being weather-proofed.
- Ancillaries
  - Clamp-on temperature detector.
  - Immersion type temperature detector.
  - Controller.
  - Start-up switching and indication.
  - Manual or automatic reset facility.

8125 WATER IMMERSION THERMOSTATS:
- Standard
  - BS EN 60730-2-9.
- Use proportional type immersion thermostats with rigid sensing elements ensuring 50mm minimum length is immersed. Use separable pockets, screwed 15mm BSP.
- Pocket material
  - Copper.
  - Corrosion resistant bronze.
  - Stainless steel.
- Install pockets in positions indicated
8130 HUMIDISTATS:
- Use wall mounted resistance element type humidistats.
- Room humidity.
- Enthalpy.
9000 ACTUATORS

9010 GENERAL:
- Include position feedback devices suitable for connection to the BMS.
- Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.
- Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.

9015 SOLENOID TYPE:
- Standard
  - BS EN 60730-2-8.
- Control mode
  - Linear.
  - Proportional.
- Operation
  - Normally open.
  - Normally closed.
  - Modulating.
- Ancillaries
  - Spring return.
  - Power failure return.
  - Positioners.
  - Manual control failures.

9020 ELECTRONIC TYPE:
- Standard
  - BS EN 60730-2-8.
- Use low voltage, high torque, electronic type actuators, including mounting brackets, adjustable linkages and necessary attachment devices.
- Control mode
  - Linear.
  - Proportional.
  - Compensating.

9030 ELECTRIC MOTOR:
- Operation
  - Unidirectional.
  - Reversible.
  - Synchronous.
  - Asynchronous.
- Provide thermal overload protection with manual reset option.
- Spring return.
- **Control mode**
  - Linear.
  - Proportional.
  - Compensating.
- **Operation**
  - Two-position (ON-OFF).
  - Continuous.
  - Modulating.
- **Electrical requirements**
  - Integral terminal strip or DIN plug and socket connections.
  - Two end of travel limit switches, with adjustable cam operation for motor de-energisation.
- **Mechanical requirements**
  - Self locking gear train.
  - Manual override, geared to prevent backlash.
  - Travel stops in each direction.
  - Position indicator.
  - Enclose to IP65 minimum.
- **Ancillaries**
  - Auxiliary switches.
  - Heater.
  - Potentiometers.
  - Proportional current feedback modules.
  - Positioners.
  - Speed adjustment modules.
  - Integral controllers.
  - Manual control facilities.
  - Power failure return.
  - Spring return.
1000 VALVES AND DAMPERS

1010 MOTORISED VALVES:

- Standard
  - BS EN 60730-2-8.
- Type
  - Single seat.
  - Double seat.
  - Three-way mixing.
  - Three-way diverting.
  - Butterfly.
  - Multi-port.
  - Low flow.
  - Pilot operated.
- Material
  - Brass to BS EN 12163, BS EN 12164 or BS EN 12167.
  - Copper alloy to BS EN 1982.
  - Cast iron to BS EN 1561.
  - Cast steel to BS EN 10213.
- Connections
  - Screwed to BS 21 and BS EN 10226-1.
  - Flanged to BS EN 1092-3 PN
  - Cast steel only, flanged to BS EN 1092-1
  - Cast iron only, flanged to BS EN 1092-2
  - Aluminium alloy only to BS EN 1092-4
- Ancillaries
  - Position indicator.
  - Locking device.
  - Control device and linkage mechanisms.
- Actuating motive power
  - Solenoid.
  - Electric motor.
  - Pneumatic.
  - Magnetic.

1020 CONTROL BALL VALVES:

- Valve
  - Control valve.
  - Open/Close valve.
  - Two way.
• Three way.
• Rotary Actuator
  • Open/close.
  • Modulating.
  • 3-point.
• Material
  • Nickel-plated brass.
  • Stainless steel ball.
  • Seal - PTFE.
  • Stainless steel spindle.
  • Spindle seal - EPDM.
• Connections
  • Threaded to BS 21 and BS EN 10226-1.
• Ancillaries
  • Lever for manual operation.

1030 MOTORISED DAMPERS:
• Use motorised control dampers manufactured and installed in accordance with DW 144.
  • Actuating motive power
    • High torque-electronic.
    • Electric motor.
    • Pneumatic.

1040 MOTORISED SHUTTERS:
• Use motorised shutters manufactured and installed in accordance with DW 144.
• Actuating motive power
  • Electric Motor
  • Pneumatic
1110 GENERAL:
- Type
- Application
- Manufacturer and references
  - Or approved equivalent
- As shown on drawings/schedules
- Provide switchgear and controlgear accessories.
  - Cylinder locks on hinged doors, with 2 keys for each lock.
  - Provide each switchboard with sets of padlocks.
  - Provide non-interchangeable, high security five-lever type padlocks, unless otherwise indicated.
  - Provide each padlock with two keys complete with disc and ring. Engrave disc and padlock with suitable legend.
  - Provide wall mounted steel cabinet with hinged door for storing padlocks and keys on hooks. Supply case with finish to match switchboard.
  - Insulating mats to BS 921
  - Along full length of switchboard.
- Width
- Thickness
- Construction
  - Plain.
  - Patterned.
- Switchgear operating tools
- Spare fuses.
  - 5% of each rating and type on switchboard.
  - Mounted in cupboard integral with switchboard.

1120 WORKMANSHIP:
- Application
- Fixing
  - Fix all equipment independently of wiring system. Use cadmium or zinc electroplated bolts, nuts, washers and screws.
- Mounting height
  - Mount single items of equipment 1450mm above finished floor level to centre of equipment, unless otherwise indicated.
  - Arrange groups of equipment, other than floor mounted assemblies, so that all parts of equipment requiring access for operation or maintenance are at least 500mm and no more than 2000mm above finished floor level, unless otherwise indicated.
• Access
  • Ensure that clearance in front of switchgear and controlgear is not less than 1m, or as indicated.
• Marking and drawing
  • Number terminals, cables and component parts to correspond with manufacturer's certified drawings.
  • Reference
  • Number terminals, cables and component parts to correspond with manufacturer's certified drawings.
• Cable terminations
  • Terminate paper-insulated cable by means of switchboard manufacturer's standard compound filled cable boxes.
  • Terminate PVC SWA PVC and MICS cables inside enclosure by securing cables to switchboard with glanding plates or glanding brackets; and outside enclosure with glanding plates or fabricated steel extension boxes.
  • Install and commission switchgear and controlgear in accordance with the appropriate standard and the manufacturer's recommendations. Include CT Polarity check in commission tests.
• Engage specialist to commission switchboards.
  • Equipment manufacturer.
• Engage specialist to commission controlgear and motor control centres.
  • Panel assembler.
  • Control specialist
1200 CONTACTORS AND STARTERS

1210 GENERAL:
- Supply contactors and starters as specified in work section
- Supply contactors and starters as schedule reference
- Location
  - At end of this work section
  - On drawing number

1220 CONTROL PANELS:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent
- Details
- Control panel design
  - Ensure that the layout of control panels reflects the layout of the plant being served. Ensure that indicators and controls for associated plant are grouped.
  - Ensure that all doors on panels containing exposed dangerous voltages are provided with interlocked isolators such that the door cannot be opened except with the isolator in the ‘off’ position. Ensure that isolation complies with BS 7671.
  - Ensure that equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding safety interlocks. Ensure that in general, field controllers are not located within control panels where isolation is necessary to gain access.
  - Design panels to maintain all components within their environmental tolerance limits taking into account ambient environmental conditions. Install fans with thermostatic control and air extract grilles and air intake grilles with replaceable filters where mechanical ventilation is required to control the environmental conditions. Ensure that the specified ingress protection (IP) ratings are maintained.
- Control panel construction
  - Construct control panels to IP54. Construct the panels using sheet steel, folded and seam welded to form a rigid self-supporting structure. Ensure that bracing and stiffening is used as necessary to take the weight of internal components and control assemblies. Ensure that no sharp corners are present.
  - Ensure that control panels weighing more than 50 Kg including installed components are fitted with eyebolts to facilitate delivery and installation.
  - Ensure that panels are provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable trunking intended for termination within the panel.
  - Arrange all wiring within the panel in looms and/or perforated trunking. Ensure that all cables are run continuously from terminal to terminal without intervening
joints.
- Ensure that all terminations are fully shrouded, recessed or otherwise protected against accidental contact.
- Ensure that where live equipment cannot be isolated it is covered with a perspex shield carrying appropriate warning labels in addition to specified shrouding.
- Ensure sufficient spare capacity in cable ways and trunking to comply with BS 7671.
- Ensure that flexible looms are used to connect door mounted to interior-mounted components such that wires will not weaken or break with repeated door openings. Arrange the loom to avoid pinching or looping when the door is closed and ensure that it is fully supported at each end.

- Control panel labelling
  - Ensure that all panels and individual panel sections are provided with exterior labels to BS 5499-5 indicating the voltage within the panel along with clear warnings of risk and instructions for isolation. Display requirements for informing the BMS supervisor and/or disabling alarms prior to isolation of control circuits.
  - Label all switches, controls and indicators on control panels as to function and associated plant.
  - Fix a notice to the front of the panel warning of the need for isolation elsewhere if the panel does not totally control the electricity supply to associated plant.
  - Identify all cables with permanently fixed ferrules. Ensure that the numbering corresponds to the numbers fixed to the terminals. Ensure that identification and coding matches that used on the design drawings, schematics and schedules.

- Electrical supply
  - 3 phase
    - Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  - Single phase
    - Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.

- Surge suppressors
  - Manufacturer fitted
    - Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by Manufacturer.
  - Installer fitted
    - Supply surge suppressors to star connected motors and to all motors subject to star-delta starting to limit peak voltage to 1200 volts. Fitted by installer.

- Transient suppressors
  - Manufacturer fitted
    - Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by Manufacturer.
  - Installer fitted
Supply transient suppressors in the form of resistor and capacitor networks across the starter contactor coils. Fitted by installer.

- Controlgear assembly
- Standard - BS EN 60439-1

- External design
  - Cubicle type assembly.
  - Multi-cubicle type assembly.
  - Desk type assembly.
  - Box type assembly.
  - Multi-box type assembly.

- Usage
  - Control panel.
  - Motor control centre.
  - Single starter enclosure.

- Conditions of installation
  - Indoors.
  - Outdoors.

- Electrical characteristics
  - Rated operational voltage
  - Rated insulation voltage
  - Rated current
  - Rated short-time withstand current
  - Rated peak withstand current
  - Rated prospective short-circuit withstand current
  - Rated conditional short-circuit current
  - Rated fused short-circuit current
  - Rated diversity factor
  - Prospective short-circuit current
  - Arising from rotating machine
  - Co-ordinate short-circuit protection devices

- Service conditions
  - Ambient air temperature as BS EN 60439.
  - Suitable for ambient air temperature for outdoor installations
  - Altitude as BS EN 60439.
  - emc
  - Environment 1.
  - Environment 2.
  - Suitable for use at altitudes above 1000m.
  - Special service conditions
  - Remedies for electrical and radiated interferences
  - Conditions during transport, storage and erection
- Provide facilities to allow future extension of switchboard
- Assembly construction
  - Enclosure standard - BS EN 62208.
  - Material of enclosure - Manufacturer's standard.
  - Terminals for external conductors, main power circuits
  - Accommodate cross-sectional area of copper cables in accordance with BS EN 60439-1, Appendix A.
- Terminals for external conductor, control and auxiliary circuits
  - Terminal block. Mounting - top hat rails (35mm) to BS 5584 (EN 50022).
  - Size of neutrals on three phase supplies
  - Full current-carrying capacity of phase conductor.
- Degree of protection to BS EN 60529
  - IP 31 for units installed inside buildings excluding boiler rooms and pump rooms.
  - IP 55 for units installed in boiler rooms, pump rooms and outside buildings.
- Protection against direct and indirect contact as Manufacturer's standard.
- Accessibility for inspection
  - Arrange for following operations to be performed when assembly is in service and under voltage.
    - Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
    - Adjusting and re-setting of relays, releases and electronic devices.
    - Replacement of fuselinks and indicating lamps.
    - Fault location by voltage and current measuring.
    - Accessibility for maintenance
- Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
  - Use barrier protected sub-sections for each functional unit or group.
  - Use compartments for each functional unit or group.
  - Removable parts and withdrawable parts
  - Degree of protection of assembly after removal or withdrawal of part as manufacturer's standard.
  - Internal separation - Manufacturer's standard.
  - Input voltage variations for electronic equipment supply - BS EN 60439, Section 7.9.1.
  - Supply frequency deviation - BS EN 60439, Section 7.9.4.
  - Mounting - Floor standing or wall mounted.
  - Access for cabling
  - As shown on drawings/schedules
- Enclosure standard - BS EN 62208.
- Material of enclosure
• Manufacturer's standard.
• Steel.
• Impact resistant moulded plastic
• Terminals for external conductors, main power circuits
  • Accommodate cross-sectional area of copper cables in accordance with BS EN 60439-1, Appendix A.
  • Accommodate cross-sectional area of copper cables
  • Accommodate cross-sectional area of aluminium cables
• Terminals for external conductor, control and auxiliary circuits
  • Terminal block
  • Fused
  • Removable link
  • Socket for test pin
  • Mounting.
  • Removable backplates.
  • Top hat rails (35mm) to BS 5584 (EN 50022).
  • Top hat rails (75mm) to BS 5585 (EN 50023).
• Size of neutrals on three phase supplies
  • Full current-carrying capacity of phase conductor.
• Degree of protection to BS EN 60529
  • For assembly
  • For bottom plate
  • IP 31 for units installed inside buildings excluding boiler rooms and pump rooms.
  • IP 55 for units installed in boiler rooms, pump rooms and outside buildings.
• Degree of mechanical protection to BS EN 62262, IK
• Protection against direct contact
  • Manufacturer's standard.
  • Protection by insulation of live parts.
  • Protection by barriers or enclosures.
  • Protection by obstacles.
• Protection against indirect contact
  • Protection by using protective circuits.
  • Protection by separation of circuits.
  • Protection by total insulation.
• Accessibility for inspection
  • Arrange for following operations to be performed when assembly is in service and under voltage.
  • Visual inspection of switching devices and other apparatus; settings and indicators of relays and releases; conductor connections and markings.
  • Adjusting and re-setting of relays, releases and electronic devices.
  • Replacement of fuselinks.
- Replacement of indicating lamps.
- Fault location by voltage and current measuring.

- Accessibility for maintenance
  - Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
  - Use barrier protected sub-sections for each functional unit or group.
  - Use compartments for each functional unit or group.

- Accessibility for extension under voltage

- Removable parts and withdrawable parts
  - Degree of protection of assembly after removal or withdrawal of part as manufacturer's standard.

- Internal separation
  - Form 1.
  - Form 2.
  - Form 3.
  - Form 4.

- Input voltage variations for electronic equipment supply
  - BS EN 60439, Section 7.9.1.

- Supply frequency deviation
  - BS EN 60439, Section 7.9.4.

- Mounting
  - Floor standing.
  - Wall mounted.

- Access for cabling
  - Front
  - Top
  - Bottom
  - Rear
  - Side

- Enclosure finish
  - Apply high standard finish to enclosure and supporting metalwork. Degrease metal and remove rust prior to applying finish.
  - Comply with paint manufacturer's recommendations regarding preparation, stoving times, temperatures, mixing of finishes, application and coat thickness.

- Finish
  - Paint.
  - Stove enamel finish.
  - Epoxy enamel finish.
  - Corrosion resistant paint finish.
  - Manufacturer's standard.
• Colour
  • Manufacturer's standard colour.
  • Colour to BS 381C
  • Colour to BS 4800
• Sample
  • Provide specimen steel frames and panels for each stage of each type of paint system and for each colour.
• Site modification
  • Do not make site alterations unless authorised. Where site modifications to assemblies are authorised make in accordance with manufacturer's certified drawings and instructions. Ensure that modifications made comply with type test certificate obtained for arrangement of components.

1230 LV CONTACTORS AND MOTOR STARTERS:
• Type
• Application
• Manufacturer and reference
  • Or approved equivalent
• Electrical supply
  • 3 phase
  • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
  • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
• LV contactors
  • Eight hour
  • Standard - BS EN 60947-4-1 or BS EN 60947-4-2.
  • Type of equipment - A.c. mechanical contactor. Interrupting medium, air.
  • Operating condition.
    • Method of operation - Electromagnetic.
    • Method of control - Automatic. Rated and limiting values for the main circuit.
  • Rated voltage (Volts) - Operational, 400.
  • Rated duty - Eight-hour.
  • Operational performance.
    • One rotation direction, with motor stopping between operations.
  • Control circuits
    • Electrical - ac; rated frequency (Hertz), 50; rated voltage (Volts), 230.
    • Co-ordination with short-circuit protective devices - Type 1
    • Enclosure degree of protection to BS EN 60529, IP 31.
Minimum mechanical and electrical endurance
- Mechanical 0.3 million; electrical 15,000.
- Provide mechanical and electrical interlocks to prevent simultaneous closure of paired contactors.
- Uninterrupted
- Standard - BS EN 60947-4-1 or BS EN 60947-4-2.
- Type of equipment - A.c. mechanical contactor. Interrupting medium, air.
- Operating condition.
- Method of operation - Electromagnetic.
- Rated and limiting values for the main circuit.
- Rated voltage (Volts) - Operational, 400.
- Rated duty - Uninterrupted.
- Operational performance.
  - One rotation direction, with motor stopping between operations.
- Control circuits
  - Electrical - ac; rated frequency (Hertz), 50; rated voltage (Volts), 230.
- Co-ordination with short-circuit protective devices - Type 1
- Enclosure degree of protection to BS EN 60529, IP 31.
- Minimum mechanical and electrical endurance
  - Mechanical 0.3 million; electrical 15,000.
- Provide mechanical and electrical interlocks to prevent simultaneous closure of paired contactors.
- Continuous
- Standard - BS EN 60947-4-1 or BS EN 60947-4-2.
- Type of equipment - A.c. mechanical contactor. Interrupting medium, air.
- Operating condition.
  - Method of operation - Electromagnetic.
- Rated and limiting values for the main circuit.
- Rated voltage (Volts) - Operational, 400.
- Rated duty - Continuous.
- Operational performance.
  - One rotation direction, with motor stopping between operations.
  - Control circuits
    - Electrical - ac; rated frequency (Hertz), 50; rated voltage (Volts), 230.
  - Co-ordination with short-circuit protective devices - Type 1
  - Enclosure degree of protection to BS EN 60529, IP 31.
  - Minimum mechanical and electrical endurance
    - Mechanical 0.3 million; electrical 15,000.
  - Provide mechanical and electrical interlocks to prevent simultaneous
closure of paired contactors.

- Details of equipment
- As shown on drawings/schedules
- Number of poles
- Rated operational current (Amps)
- Utilisation category
- Relays and releases, type
- Short circuit protection devices

- Standard
  - BS EN 60947-4-1.
  - BS EN 60947-4-2.
  - BS EN 61095.
  - BS 5424-2.

- Equipment
  - Contactor
  - Mechanical.
  - Electromechanical.
  - Pneumatic.
  - Electro-pneumatic.
  - Latched.
  - Vacuum.
  - Household and similar purposes.

- Semiconductor motor control device
  - Motor controller.
  - DOL motor controller.
  - Motor starter.
  - DOL motor starter.
  - Hybrid motor controller Type A.
  - Hybrid motor controller Type B.
  - Hybrid motor starter.
  - Form
  - 1.
  - 2.
  - 3.
  - Motor-starter.
  - Direct on line.
  - Reversing.
  - Two direction.
  - Reduced voltage.
  - Star delta.
  - Auto-transformer.
• Rheostatic.
• Stator.
• Rotor.
• Combination.
• Protected
• Manual.
• Electromagnetic.
• Motor-operated.
• Pneumatic.
• Electro-pneumatic.
• Single step.
• Two step.
• n-step
• Number of poles.
• 4 pole.
• 3 pole.
• Double pole.
• a.c.
• d.c.
• Interrupting medium.
• Air.
• Oil.
• Operating condition.
• Method of operation.
• Manual.
• Electromagnetic.
• Motor operated.
• Pneumatic.
• Electro-pneumatic.
• Method of control.
• Automatic.
• Non-automatic.
• Semi-automatic.
• Method of change-over
• Method of connection
• Rated and limiting values for the main circuit.
• Rated voltage (Volts).
• Operational
• Stator
• Rotor
• Insulation
• Stator
• Rotor
• Auto-transformer starting voltage (Volts)
• Currents (Amps).
• Conventional free air thermal
• Conventional enclosed thermal
• Conventional stator thermal
• Conventional rotor thermal
• Rated operational.
• Current (Amps)
• Stator
• Rotor
• Rated uninterrupted current (Amps)
• Rated frequency (Hertz)
• Rated duty.
• Eight-hour.
• Uninterrupted.
• Continuous.
• Intermittent.
• Class
• Temporary.
• Value
• Periodic.
• Duty cycle
• Normal load and overload characteristics.
• Motor switching overload current withstand (Amps)
• Rated making capacity (Amps)
• Rated breaking capacity (Amps)
• Conventional operational performance
• Overload current profile.
• Short-circuit characteristics (Amps)
• Rated short-time withstand current (Amps)
• Rated short-circuit making current (Amps)
• Rated short-circuit breaking current (Amps)
• Rated conditional short-circuit current (Amps)
• Operational performance.
• One rotation direction, with motor stopping between operations.
• Two rotation directions, with motor stopping between operations.
• One or two rotation directions, with infrequent inching.
• One rotation direction, with frequent inching.
• One or two rotation directions, with infrequent plugging for stopping.
Two rotation directions, with plugging.
Utilisation category.
AC 1.
AC 2.
AC 3.
AC 4.
AC 5a.
AC 5b.
AC 6a.
AC 6b.
AC 7a.
AC 7b.
AC 8a.
AC 8b.
AC 52a.
AC 52b.
AC 53a.
AC 53b.
AC 58a.
AC 58b.
Control circuits
Electrical
ac
dc
Rated frequency (Hertz)
Rated voltage (Volts)
Rated supply voltage (Volts)
Auxiliary circuits
Relays and releases.
Type.
Shunt trip.
Under voltage.
Under current.
Overload time delay.
   Delay independent of load (Magnetic)
   Delay dependent on load (Thermal)
Instantaneous over current
Phase loss
Control relay
Relay or release characteristics.
Rated voltage (Volts)
• Rated current (Amps)
• Rated frequency (Hertz)
• Operating voltage (Volts)
• Operating current (Amps)
• Overload relay.
  • Designation
  • Current settings (Amps)
  • Time/current characteristics
  • Trip class.
    • 10A
    • 10
    • 20
    • 30
  • Maximum tripping time (Seconds)
  • Number of poles
  • Nature of relay.
    • Thermal.
    • Magnetic.
    • Solid state.
• Co-ordination with short-circuit protective devices.
• Type 1
• Type 2
• Short circuit protection devices
• Provide verification of co-ordination with short circuit protection devices.
• Switching over voltages (Volts)
• Enclosure degree of protection to BS EN 60529 IP
• Pollution degree
• Industrial (degree 3).
• Household etc. (degree 2)
• Minimum mechanical and electrical endurance:-
  • Mechanical 0.3 million electrical 15,000.
  • Mechanical 1 million electrical 50,000.
  • Mechanical 3 million electrical 150,000.
  • Mechanical 10 million electrical 500,000.
• Provide mechanical and electrical interlocks to prevent simultaneous closure of paired contactors.
• Provide mechanical and electrical interlocks to paired contactors

1240 CONTROL CIRCUIT DEVICES:
• Type
• Application
• Manufacturer and references
  • Or approved equivalent
  • Supply Voltage
  • Ensure control circuits are 230 volt AC or DC or 230 volt AC single phase connected one single phase to neutral only.
  • Circuit Voltage
  • Where control circuits are taken outside the panel
  • Use 24 volt operating supply.
  • Use 230 volt operating supply.

• Electrical supply
  • 3 phase
  • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
  • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.

• Details
  • As shown on drawings/schedules
  • Number of poles
  • Rated operational current (Amps)
  • Utilisation category
  • Electrically separate contact elements

• Standard - BS EN 60947-5-1

• Equipment.

• Control circuit device.
  • Manual control switches
  • Emergency stop.
  • Control relays
  • Pilot switches
  • Position switches
  • Associated equipment
  • Auxiliary contacts.
  • Contactor.
  • Circuit breaker.
  • Indicating lamps etc.

• Number of poles
  • a.c.
  • d.c.

• Interrupting medium

• Operating condition.
  • Method of operation.
- Electromagnetic.
- Pneumatic.
- Electro-pneumatic.
- Method of control.
- Automatic.
- Non-automatic.
- Semi-automatic.
- Rated and limiting values for the main circuit.
  - Rated voltage (Volts).
  - Operational
  - Insulation
  - Impulse withstand
  - Currents (Amps).
  - Conventional free air thermal
  - Conventional enclosed thermal
  - Rated operational.
  - Current (Amps)
  - Rated frequency (Hertz)
  - Normal load and overload characteristics.
  - Rated making capacity (Amps)
  - Rated breaking capacity (Amps)
  - Short-circuit characteristics (Amps)
  - Rated conditional short-circuit current (Amps)
  - Switching over voltages (Volts)
  - Contact element classification.
  - Utilisation category.
  - AC 12
  - AC 13
  - AC 14
  - AC 15
  - DC 12
  - DC 13
  - DC 14
- Electrical rating.
- Alphabetic code.
  - A
  - B
  - C
  - D
  - E
AfDB: Electrical Specifications

1250 ISOLATING SWITCHES:

- Type
- Application
- Manufacturer and reference
  - Or approved equivalent
- Electrical supply
  - 3 phase
    - Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  - Single phase
    - Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
    - Isolation as shown on drawings/schedules
- Standard - BS EN 60947-3.
- Provide independent manual operation type isolating switches with rated duty, rated operational current and utilization category compatible with contactor.
- Isolation
  - Do not interlock main isolator with compartment door.
  - Provide main isolator with own enclosure door.
  - Ensure drive disconnector isolates all circuits including those from external
sources of supply.

1260 CONTROL SELECTOR SWITCHES:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent
- Electrical supply
  - 3 phase
    - Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  - Single phase
    - Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
- Standard - BS EN 60947-5-1
- Provide panel mounting independent manual operation rotary type switch to select local/off/remote control.
- Ensure switch rated thermal current, rated operational current, and utilization category are compatible with contactor control circuit characteristics and circuit protection device.

1270 IN-BUILT PUSH BUTTONS:
- Type
- Application
- Manufacturer and reference
  - Or approved equivalent
- Electrical supply
  - 3 phase
    - Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  - Single phase
    - Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
- Standard - BS EN 60947-5-1.
- Provide panel mounting type push buttons with actuator colours to BS EN 60073.
- Supply flush button type start/on and reset push buttons. Supply mushroom actuator type stop/off push buttons released by turning the actuator.
- Ensure rated thermal current, rated operational current and utilization category of push button contacts are compatible with contactor control circuit characteristics and circuit protection device.

1280 INDICATOR LIGHTS AND ALARMS:
• Type
• Application
• Manufacturer and reference
  • Or approved equivalent
• Lights
  • Use 12 volts low wattage filament type indicator lights. Where required for electronic equipment use high intensity neon-type indicator lights.
  • Colours
• Electrical supply
  • 3 phase
    • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
    • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
• Supply lamps of same type throughout. Provide indicator lamps with lamp test facility.
• Standard - BS EN 842 and BS EN 60947-5-1.
• Details
  • Supply lamps of wattage indicated.
  • Supply interchangeable indicators for respective units.
  • Include an integral double wound transformer for each lamp unit on ac indicator circuits.
  • Include an integral ballast resistor for each lamp unit on dc indicator circuits.
  • Provide neon indicators.
  • Provide 24V indicator circuits for 30V lamps.
  • Provide 230V indicator circuits and lamps.
  • Protect wiring to indicator lamp units by separate cartridge fuses.
  • Lens Colour - In accordance with BS EN 60073.

1290 CONTACTOR CONTROL RELAYS:
• Electrical supply
  • 3 phase
    • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
    • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
• Standard BS EN 60947-5-1, install relays in contactor enclosure.
• Relay enclosure protection to BS EN 60529
• Compatible with contactor enclosure.
• Standard- BS EN 60947-5-1
  • Install relays in contactor enclosure.
  • Install relays in separate enclosures and interconnect relays with contactor control circuits.
• Relay enclosure protection to BS EN 60529
  • Compatible with contactor enclosure.
  • IP 31.
  • IP 55.
• Time relays to BS EN 61812-1

1291 CONTROL AND INDICATOR CIRCUIT FUSES:
• Electrical supply
  • 3 phase
    • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
    • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
• Provide in contactor enclosure separate low voltage fuse bases, fuse carriers and cartridge fuses for protection of control circuits and indicator light circuits.
• Fuses
  • Fully shrouded impact resistant moulded plastic fuse bases and carriers in accordance with BS EN 60269 (BS 88). Supply category gG cartridge fuses to BS EN 60269 (BS 88).
  • Fully shrouded impact resistant moulded plastic fuse bases and carriers in accordance with BS EN 60127-6.
  • Cartridge fuses in accordance with BS EN 60127-2.

1292 MOTOR STARTERS:
• Electrical supply
  • 3 phase
    • Ensure all electrical equipment supplied and installed is suitable for 3 phase power supply to BS 7697.
  • Single phase
    • Ensure all electrical equipment supplied and installed is suitable for single phase power supply to BS 7697.
• General
  • Provide fuses or circuit breakers for motors below 0.37kW.
  • Provide starters incorporating overcurrent protection for motors above 0.37kW
  • Provide starter with manual reset, adjustable, inverse time delay, and ambient temperature compensated thermal overcurrent release to BS EN 60947-4-1. Ensure
overcurrent release is compatible with starting, accelerating and running characteristics of motor, starter and driven machine combination. Use phase unbalance protection on three phase equipment.

- Provide starter with sensitive discriminating thermal magnetic overcurrent relay with precise time/current characteristics to BS EN 61810. Protect motor against effects of sustained and cyclic overcurrent, out of balance phase current, stalled condition and earth faults. Use running load indication type overcurrent relays with accuracy of setting and indication within plus or minus 3 per cent, expressed as a percentage of setting indicated.

- Provide solid state overcurrent protection

- Current limiting type
  - Use static type thyristor voltage control starter to provide reduced current starting.
  - Provide adjustable ramp times.
  - Provide contactor for switching and disconnector for isolation.
  - Provide details of harmonic distortion content prior to ordering.

- Direct-on-line type
  - Use direct-on-line starter to BS EN 60947-4-1, with single phase motors and three phase motors.

- Star delta type
  - Use star delta starter to BS EN 60947-4-1 with three phase motors.
  - Incorporate adjustable time delay contactor relays, to control star delta changeover, ensuring electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

- Auto-transformer type
  - Use auto-transformer starter to BS EN 60947-4-1 with three phase motors.
  - Provide 2 step closed transition auto transformers suitable for 3 operating cycles per hour.
  - Provide auto transformers with three tappings for selection of motor starting voltage. Arrange tappings to limit motor starting current to 80 per cent, 65 per cent and 50 per cent of full voltage starting current.
  - Incorporate adjustable time delay contactor relays, to control automatic changeover from selected reduced voltage to full voltage, having an electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

- Stator rotor type
  - Use stator rotor starter to BS EN 60947-4-1 with three phase motors.
  - Provide starter resistors suitable for indicated operating cycles per hour.
  - Incorporate adjustable time delay contactor relays, to control starter resistor short circuiting contactors, having electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

- Operating cycles per hour
  - Use stator rotor starter to BS EN 60947-4-1 with three phase motors.
  - Provide starter resistors suitable for indicated operating cycles per hour.
W69  BUILDING MANAGEMENT SYSTEM

- Incorporate adjustable time delay contactor relays, to control starter resistor short
circuiting contactors, having electrical endurance compatible with starter contactors.
Ensure starting sequence activated on voltage restoration.
- Inverter type
- Supply inverters to control speed of standard AC Squirrel cage motors.
  - Inverter type
    - Digital PWM.
  - Location
    - Control panel.
    - Motor control centre.
  - Control range
    - 0.5 to 120 Hz
  - Power factor
    - Provide near unity power factor over speed range without the use of power factor
correction condensers.
    - 0.95 or better.
  - Starting current
    - Not to exceed 1 x FLC.
  - Characteristics
    - Ensure acceleration and deceleration ramps are independently adjustable.
    - Allow connection to a turning motor without braking to a standstill.
    - Allow connection to a reverse windmilling fan without causing tripping and return
fan to correct speed.
    - Ensure inverters require no additional means for starting.
    - Supply inverters that do not require electrical matching to motor.
    - Ensure inverters are capable of running motors in parallel.
    - Ensure electronic maintenance and commissioning can be carried out without
motor being connected.
    - EMC characteristics to BS EN 61800.
  - Mains interruption
    - Ensure inverter does not cause tripping through a mains interruption of
      - 500 msec.
      - 200 msec.
  - Protection
    - Ensure inverter incorporates the following protection to cause electronic shut
down without operating circuit protective devices.
      - Motor phase to phase fault.
      - Motor phase to earth fault.
      - Overvoltage.
      - Undervoltage.
      - Inverter overheat.
• Motor overheat.
• Stall protection.
• Loss of control signal.
• Loss of auxiliary control voltage.
• Current limit.

• Inverter controls
  • Local/remote facility.
  • Provide a means of running at a fixed, selectable speed on closure of a remote volt free contact. Ensure this over-rides the normal speed control reference signal.

• Display
  • Make provision for inverter to display externally, external and internal faults following a failure.
  • Show 1st, 2nd and 3rd up sequential faults.
  • Provide digital readout to show
    • Output frequency Hz.
    • Reference 1 (Hand).
    • Reference 2 (Auto).
    • Motor current (% or Amps).
    • Torque (% x PN).
    • DC Link voltage (%).
    • Temperature (°C).
    • Fault memory.
  • Provide volt free remote signalling contacts to indicate:
    • Overcurrent.
    • Frequency alarm.
    • Common fault.
    • Reference fail alarm.
    • Running/stopped conditions.
    • Healthy/tripped conditions.

• Ensure parameters can be set and fault memory interrogated with door closed, and without additional instrumentation.

1293 AUTOMATIC CHANGEOVER FOR RUN/STANDBY DUTY:

• Application
• Dual power supply
  • Fit a control switch to starter enclosure arranged to select either motor for "run" or "standby" duty.
  • Indicate selection of respective motor and availability of the two power supplies by illumination of indicator lights on starter enclosure.
  • Provide facilities for connection of remote indicator lights to indicate selection/operation of system and for connection of a system malfunction audible
alarm where indicated.
• Arrange for selected "run" duty motor to operate in response to system controls,
and on loss of power supply to "run" duty motor or operation of motor starter
overcurrent trip, for automatic changeover to "standby" motor.
• Control the two power supplies by a single air break multiple isolating switch
interlocked with starter enclosure access door.
• Provide system malfunction audible alarm.

**1294 CONTROL CIRCUIT TRANSFERS:**
• Provide control circuit transformers to supply power at voltages to suit control
components.
• Standard
• Use transformers in accordance with BS EN 61558-2-9, BS EN 61558-2-23 or BS
EN 61558-1 and provide an external label of approved type and size.
• Protection - Primary and secondary fuses.

**1295 SWITCHING AND INDICATION:**
• As shown on drawings/schedules
• Provide switches, indicating lamps, instruments and controls of uniform appearance
and physically protected.
• Switches and indicators
  • Fit on panel or access doors
  • Motor circuit isolating switches.
  • Stop/Start/Reset push buttons.
  • Auto/Off/Manual control selector switch.
  • Run and trip indicator lights.

**1296 AUDIBLE ALARMS:**
• Application
• Audible alarms
  • Ensure that operation of any starter trip lamp, safety circuit lamp or alarm lamp
operates a common audible alarm with mute and test facilities and terminals for
remote alarm signal.
  • When an alarm condition has had the audible alarm muted, ensure that terminals
for a remote 'alarm accepted' light are energized. The audible alarm circuit and
terminals for remote alarm signal must still be capable of indicating another fault
occurring even though original fault has not been cleared. The test facilities are to
test momentarily both the audible alarm and all alarm indicator lamps, whilst the push
button is depressed.
  • Use alarms that interface with a sensor or controller to sense set-point and
measured value. Provide adjustable upper and lower limits on face of unit. Provide
unit with indicating lamps to show which limit has been exceeded. Provide each unit
with connections for remote alarm.

1297 STARTER AND CONTROL PANEL WIRING:
- Type
- Application
- Standard
  - BS 6231
- Wiring coding
  - Random colours.
  - CPC green/yellow
  - Functional earth
- Control wiring
- Type
- Application
- Mount all components of the switchgear and controlgear in accordance with the manufacturer's instructions.
- Mount control components
  - On removable backplates.
  - On top hat rails (35mm) to BS 5584 (EN 50022).
  - On top hat rails (75mm) to BS 5585 (EN 50023).
  - Segregate control wiring from power circuits.
  - Contain control wiring in ventilated plastic trunking.
  - Identify each end of each wire with a unique number.
- Power wiring
  - Take account of thermal effects of grouping when routing power wiring.
  - Identify each end of each wire with a unique number.

1298 COMPONENT MOUNTING:
- Type
- Application
- Mount all components of the switchgear and controlgear in accordance with the manufacturer's instructions.
- Mount control components
  - On removable backplates.
  - On top hat rails (35mm) to BS 5584 (EN 50022).
  - On top hat rails (75mm) to BS 5585 (EN 50023).
1300 POWER CONDITIONING

1310 POWER CONDITIONING REQUIREMENTS:

- Type
- Application
- Manufacturer and reference
  - Or approved equivalent.
- Style
  - Combined unit
  - Integral
  - Wall plate.
  - In lead
  - Plug top.
  - Distribution board
  - Power distribution unit
  - Plug board
  - Standby power supply
  - Uninterruptible power supply
  - Data line protector
- Power Input
  - Frequency
  - Voltage
  - Current
- Filters
  - Current rating
  - Normal mode rejection
  - Common mode rejection
  - Transverse mode rejection
  - Insertion loss symmetrical
  - Insertion loss asymmetrical
- Surge Protection
  - Anti surge fuses
  - Surge diverters
  - Voltage dependent resistors
  - Active filters
  - Clamping threshold
  - Clamping time
  - Total energy dissipated
  - Total energy dissipated common mode
  - Total energy dissipated normal mode
  - Total energy dissipated transverse mode
- Peak transient power
- Clipping level
- Clipping time
- Maximum surge current
- Response time

- **Electrical Protection**
  - Fuses
  - Miniature circuit breakers
  - Residual current devices
  - Overload trips
  - Earthing
  - Bonding

- **Power Conversion**
  - Automatic voltage regulators
  - Isolating transformers
  - Transformer ratio
  - Winding screen
  - Core screen
  - Impedance
  - Regulator steps
  - Standby power supply
  - Uninterruptible power supply
  - Switching time
  - Low voltage change-over
  - DC voltage
  - Battery capacity
  - Battery Type
  - Autonomy

- **Power Output**
  - Frequency
  - Voltage
  - Current
  - Interference limits
  - Distortion limits
  - System supplier's specification for power

- **Characteristics**
  - Overall dimensions.
  - Weight.
  - Power consumption
  - Conversion efficiency
  - Mounting as BS 5954
• Separately mounted
• Mounting
1400 WORKMANSHP

1410 GENERAL:
- Install pipeline control components in accordance with manufacturer’s instructions.
- Install ductline control components in accordance with DW 144 and manufacturer’s instructions.
- Install control components in accordance with manufacturer’s recommendations, in positions indicated.

1420 APPEARANCE:
Arrange, support and clip all control wiring, pneumatic tubes and capillaries to present a neat appearance, with other services and the building structure.

1430 INSULATION:
Where control components are incorporated in insulated pipelines, ductlines or equipment, provide details for approval of method proposed to insulate component.

1440 SUPPORTS:
Arrange supports for control components to ensure no strain is imposed on components.

1450 ACCESS:
Arrange control components to ensure adequate access for operation and maintenance.

1460 POWER OPERATED CONTROLS:
Install power operated controls in accordance with manufacturer’s instructions and relevant standards.

1470 SENSORS/CONTROLLERS:
- Install sensors/controllers in accordance with manufacturer’s instructions, in accessible locations. Install wall mounted components, where indicated.
- Comply with the requirements of W60.1700.200.

1480 ANCILLARIES:
Install ancillaries in accordance with manufacturer’s instructions.

1490 ENCLOSURES:
Install enclosures where indicated, providing space for access and maintenance.

1491 BUILDING MANAGEMENT SYSTEM INSTALLATION:
Install commission and set to work building management system in accordance with the manufacturer’s recommendations.
1492 BUILDING MANAGEMENT SYSTEM QUALITY CONTROL:
- Handle, store and install equipment and components of the building management system in accordance with the manufacturer’s recommendations.
- Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
- Record all commissioning tests and site modifications to hardware or software, and revise operating and maintenance instructions accordingly.

1493 CONTROL SYSTEM FUNCTION CHARTS:
Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval of function chart before design of system hardware or writing control software.
- Function chart format.
  - Combined function chart/circuit diagram.
  - Function chart only.
1500 INSTALLATION

1510 FIXING AND CONNECTION

1510.5 CABLING INSTALLED AS PART OF THE BMS CONTRACT:
Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.
Label and record all monitoring cables in accordance with
• Cable schedules
• Cable drawings
• Application
• General
  • This part of the specification covers extra-low voltage wiring (as defined by BS 7671), i.e. signal and data communications wiring.
  • All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage or electromagnetic interference.
  • Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc from external sources to sensing devices.
  • Ensure that all wiring is carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route it to avoid interference with the correct operation or maintenance of other components.
• Cable type and application
  • Ensure that the types of cable installed do not prejudice satisfactory operation of the BMS.
  • Ensure that the type of cables, installation and planning comply with the BMS manufacturers recommendations and the project's electrical specification.
  • Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit resistance limits are not exceeded.
  • Ensure that the method of installation and routing of cables does not compromise the satisfactory operation of the BMS.
  • Ensure that the following minimum separation distances (in mm) between data/analogue signal cables and power cables are adhered to (not required if data/signal cables are in steel conduit or trunking).
• Table 7 Minimum separation distances between signal cables and power cables
  • Signal cable    Power cable    Power cable
    • Unscreened    Armoured steel wire
    • Plain    150 mm    125 mm
    • Unscreened
    • twisted pair    75 mm    50 mm
    • Screened    0 mm    0 mm
• Identification
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• Ensure that all cables have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams.

1511 USE OF EXISTING CABLE AND WIREWAYS:

• Application
  • Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of network communication is of a suitable standard for satisfactory operation of the BMS.
  • Ensure that any tests performed comply with BS EN 50174.
  • Ensure that the potential corruption of data cannot arise from:
    • Other installations not connected to, but in close proximity to, the route of existing cabling
    • Other electrical services using existing cabling
    • Other adjacent cabling.
  • State in writing at the time of tender whether or not existing cabling is suitable.

1511.5 CONNECTION TO PLANT AND CONTROL EQUIPMENT:

• Application
  • General
    • Provide all devices and terminals necessary to connect the BMS to items of plant and control equipment.
    • Take account of any existing services that have to remain in continuous operation. Agree with the Project Supervisor the method by which the BMS equipment can be installed without disrupting the operation of the building services.
    • Where plant and control equipment are supplied by others, provide the Project Supervisor with adequate details of installation requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BMS connection facilities before delivering their equipment to site.
    • Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed modifications do not invalidate the warranties.
    • Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the BMS works. Carry out proving tests to the satisfaction of the Project Supervisor.
    • Ensure that the use of existing relays, contactors, starters and switches as part of the BMS installation is fully documented.
  • Safety interlocks
    • Provide interlocks as scheduled to establish and maintain safe/pre-determined plant conditions under all modes of operation including loss, reduction and restoration of power.
    • Ensure that all safety hard-wired interlocks are wired to failsafe on loss of power,
or on relay coil failure, or on open circuit, eg cable breakage.

- Ensure that all interlocks use voltage-free contacts and 24v AC or DC relays and field wiring.
- Complete all wiring and testing of all hard-wired safety interlocks to ensure safe and/or sequenced operation of the plant before the BMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BMS.
- Ensure that plant does not operate using the BMS until all interlocks have been tested to the satisfaction of the Project Supervisor.

- **Manual control**
  - Provide manual control facilities to enable plant maintenance/facilities staff to operate essential plant in the event of BMS failure and for routine test purposes. Ensure that the facilities include:
    - Start/stop operation of the plant.
    - Automatic operation of motorised control devices such as valves and dampers, etc if the BMS is operating.
    - Manual setting of motorised control devices such as valves and dampers, etc if the BMS has failed.
    - Ensure that the manual control facilities do not override safety devices or hard-wired interlocks.

- **Volt-free contacts**
  - Ensure that the contact materials are suitable for use in the installation and at the required voltages and currents.
  - Use screw down or locking spade terminals for electrical connections to volt-free contacts.

- **Relays**
  - Use demountable relays of the totally enclosed type.
  - Use screw down clamp or locking spade-terminals, and ensure they are shrouded.

- **Signalling from starters**
  - Provide additional contacts for signalling and remote operation purposes as

- **Control equipment**
  - Obtain advice from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.
  - Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices.

- **Packaged plant**
  Ensure that connections to packaged plant are made within the packaged plant control panel. Fit an additional enclosure where this is not possible. Ensure that all connections between the BMS and packaged plant are 24v maximum.
1512 ADDITIONAL PROVISIONS FOR RETROFIT INSTALLATIONS:

• Application
  • Arrange for any necessary control modifications to existing plant to be carried out by the original supplier (with the exception of starter panels). Give the supplier details of the requirements for connection of equipment to the BMS. State the name of the supplier in the Tender together with a priced schedule for the necessary work.
  • Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications. Provide the specialist with the details of the BMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the Project Supervisor of any difficulties with connections.
  • Advise in writing at the time of tender of any potential delay to the contract arising from the difficulty of providing the necessary BMS connections to the plant.
  • Use existing relays and volt-free contacts where feasible.
  • Fit auxiliary contacts to contactors, etc where adequate space is available. Install additional relays if the space is not adequate.
  • Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.
  • Use the control manufacturer's standard accessories to provide any additional contacts, limit switches and potentiometers, etc.
  • Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices wherever possible. Obtain approval from the Project Supervisor for ad hoc fixings and modifications to control devices before action is taken on site.

1512.5 CABINETS FOR BMS EQUIPMENT:

• Type
• Application
• Manufacturer and reference
  • Or approved equivalent
• Construct BMS equipment enclosures to give the minimum degree of protection to IP54 in accordance with BS EN 60529. Where the enclosure is fitted inside another panel (eg a motor control centre) the protection can be reduced to IP41.
• Ensure that access doors are of a rigid construction and mounted on stout metal hinges capable of supporting the full weight of the open door. Ensure that doors will not sag or drop when open. Fit doors with stout locking handles to prevent access by unauthorised personnel.
• Allow safe access to the BMS equipment where the BMS equipment is incorporated into another control panel without having to isolate the panel.
1520 SENSORS

1520.5 GENERAL:

- Application
- Ensure that sensors can be removed for testing and maintenance.
- Ensure that a tight-sealing test hole is provided adjacent to every duct sensor.
- Ensure that Binder test points, or similar, are provided for pipe sensors.
- Provide a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.
- Mark and record the location of concealed sensors (e.g. in false ceilings and shafts, etc).
- Provide a labelling plate for each sensor.
- Take account of the active and inactive sections of a sensor probe.
- Take into account the effects of orientation on the functioning of the sensor.
- Take into account:
  - Minimum/maximum ambient temperature.
  - Ambient humidity.
  - Vulnerability to spray water and/or vibration.
  - Explosion protection.
  - External influences.

1520.1 TEMPERATURE SENSORS:

- Application
- Pipe-mounted immersion sensors
  - Ensure that the full active length of the sensor is immersed in water.
  - Install sensors against the direction of flow.
  - Install at the correct angle.
  - The sensor should be installed diagonally in a bypass pipe or in a bend if the active length of the sensor probe is longer than the diameter of the pipe.
  - Allow an adequate space between the sensor and the obstruction so that the sensor can be removed from the immersion pocket.
  - Ensure that immersion pockets are made from stainless steel of the appropriate pressure rating.
  - Ensure that immersion pockets are filled with a heat conducting compound.
  - A test point or an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.
  - An adequate distance (10 x pipe O) between the mixing point and the sensor should be provided when mixing water at different temperatures to take account of stratification.
- Surface temperature sensor - water
  - Ensure a smooth clean contact surface and fill the space between the sensor and
the pipe with a heat conductive compound to improve thermal conductivity.

- Immersion sensors for air (ducts)
  - The full active portion of the sensor probe should be exposed to the air flow.
  - Ensure that the active portion of the probe is located central to the airflow.
  - A test hole should be provided adjacent to every sensor with plug when not in use.
  - Probe-type sensors should not be used in areas where stratification can occur, eg downstream of heating and cooling coils, etc (see averaging sensors).
  - Sensors which are positioned near to coils should be shielded against the radiative heat transfer.
  - Return air duct sensors should be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings.
  - Sensors must be positioned in an area of representative air flow. This applies to all duct sensors but particularly the return air sensor which may be located in the ceiling plenum.
  - The likely cleanliness of the air should be considered when selecting sensors.
  - Sensors representing zone temperature should be offset to account for heat gains e.g. space temperature stratification or if light fixtures are used as the return air path.
  - Sensors should only be used in return air ducts where air is continuously extracted.

- Capillary sensors with probes
  - The device head must be higher than the sensor probe.
  - The sensor probe should be tilted downwards.
  - The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed.
  - The sensor element must always point downwards. The capillary should not form a U-shape.
  - The capillary should not be bent too tightly (radius of bend >50mm).

- Averaging sensor (for use in ducts/AHU)
  - Allow a distance of at least 50 mm between any heat exchanger and the sensor.
  - The entire length of an averaging sensor must be fully inside the air-duct.
  - The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.
  - The sensor element should be installed in the air flow, downstream of the eliminator plate when air washers are used for humidification.

- Frost protection thermostat
  - Leave a spare capillary loop of 20 cm to enable sensor testing outside the duct/unit.
  - The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space.
  - The capillary should be installed in the air flow, downstream of the first heating
coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.

- Room sensor
  - Sensors should be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.
  - The sensor should be located in an area representative of the entire control zone.
  - The sensor should be located away from heat sources, e.g. office IT equipment.
  - The sensor should be located in the area it controls.
  - Sensor locations near air currents generated by diffusers or openable windows, for example, should be avoided.
  - The sensor must not be exposed to direct solar radiation.
  - Avoid external walls except were unavoidable. Use insulated backplates.
  - Avoid recesses and alcoves.
  - The conduit entry points to the sensor wall box should be sealed where there is a risk of air from another zone flowing over the sensor element.
  - Do not install near or under lamps or above radiators.
  - Avoid chimney walls.
  - Do not install directly adjacent to doors.
  - Do not install behind curtains.
  - Do not fit to walls concealing hot-water pipes.

- Outdoor air temperature sensors
  Do not install on facades affected by significant rising heat, or facades which will be heated by solar radiation (fix sensors to a north-facing wall or use solar shields).
  Avoid chimney walls and other walls subject to high internal heat gains.
  Do not install under eaves.
  Do not install above windows.
  Do not install above ventilation extracts.

Ensure accessibility for inspection/verification
An alternative to an external mounting is to locate the sensor in the AHU intake duct. This should ideally be upstream of the intake damper. Where this is not possible it must be a suitable distance before re-circulated air and mechanical devices to avoid their effects.

1520.5 HUMIDITY SENSORS:

- Application
- Humidity sensor/stat. - duct
  - The air velocity in the vicinity of the sensor must not exceed 10 m/s (a perforated steel plate cover can be used).
  - The sensor must not be located in deadlegs (super-saturation can occur in areas where there is no air flow).
  - A test hole must be provided downstream of the sensor, plugged off when not in use.
• The sensor should be positioned beyond the spray distance of humidifiers.
• Humidity sensor/stat. - room
The sensor should be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from the adjacent wall. Avoid locations where the sensor will be exposed to direct solar radiation. Avoid external walls except where unavoidable. Use insulated backplates. Avoid alcoves and recesses. Do not install near lamps or above radiators. Do not fit to chimney walls. Do not fit directly adjacent to doors.

1520.10 PRESSURE SENSORS:
• Application
• Pressure - general
  • Pressure sensors are affected by orientation.
  • The pressure tubes must be provided with a binder point near the device head for test purposes.
  • The connection must be fitted with a bypass with a stop valve to avoid overload on one side when manipulating the sensors and to enable zero calibration. Isolating valves should also be fitted.
  • The sensor should be installed on a vibration-free surface or vibration-proof base.
  • The pressure-tapping point must not be located in turbulent air flow. Provide 6 x O/D upstream and 6 x O/D downstream of straight duct or pipe without obstructions.
• Pressure - air
  • Probes for measuring static pressure should be installed parallel to the flow.
  • The differential pressure measuring tube should be correctly sized.
  • The tapping point should not be located where it will be affected by obstructions to the flow.
• Pressure - liquids
  • Use a damping coil to avoid transferring vibrations (horizontal loops to avoid trapped air bubbles and condensate).
  • The device must always be installed in a location which is lower than the sensing point.
  • Do not measure at the top of a pipe (trapped air, bubbles) or at the bottom (dirt).
• Pressure - gases
  When measuring vapour gases the device must always be installed in a location which is higher than the sensing point. Measure at the top of the pipe to prevent condensate from entering the pressure tube.

1520.15 FLOW VELOCITY/FLOW RATE SENSORS:
• Application
• Differential pressure for flow monitoring - liquids
• There should be no stop valves or balancing valves between the sensing points on the pipework.

• Differential pressure for flow monitoring - air
  • Ensure a steadying zone upstream and downstream of the orifice plate/flow grid, etc.
  • The flow or differential pressure must not be monitored where there is a variable resistance such as a filter or fan, etc.

• Velocity sensors
  • Sensors should be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity.
  • A single point sensor should be located at a distance from the centre of the duct equal to 0.25 x the duct radius.

• Wilson flow grid
  Averaging velocity sensors across the duct, e.g. Wilson flow grid or multi-point averaging pitot tubes, should be used where the minimum separation distance from a flow disruption is not available. Ensure that the Wilson flow grid is sized correctly for each duct size.

1520.20 INDOOR AIR QUALITY SENSORS:

• Application
  • CO₂ and mixed-gas sensors - room mounted
    • Ensure that the sensor is located in a representative location, e.g. on an open wall 1.5 to 3 m above the floor.
    • Ensure that the sensor is not mounted in niches or bookshelves or behind curtains.
    • Ensure that the sensor is not located where people are continuously present (within 1 or 2 metres).
  • CO₂ and mixed-gas sensors - duct mounted
    Ensure that the sensor is located in the return air duct as close as possible to the room extract point(s).
    Ensure that the sensor is located in the vertical position.
    Ensure the correct orientation of the duct probe with respect to the airflow.
    Ensure that the sensor is not installed in a vertical position with the head at the bottom.

1520.30 ACTUATORS:

• Application
  • Securely mount actuators to rigid members, free from vibration or distortion in accordance with manufacturer’s recommendations. Select mounting positions to require minimum linkages, and to avoid angular drive to operating levers. Allow access for servicing and replacement.
  • Ensure that linkages are clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.
• Fit actuators with visual position indication.
• Ensure that there is sufficient space above the actuator so that it may be removed for testing or maintenance.
• Ensure that actuators are electrically and mechanically protected from the effects of valve or damper seizure.

1520.40 VALVES:
• Application
• General
  • Ensure that valves have the correct authority without excessive pressure drop.
  • Check for out-of-balance forces, particularly during operation of a three-port valve.
  • Where possible ensure that valves are not installed with their spindles in the horizontal position. If valves cannot be installed with their spindles in the vertical position ensure that they are as near as possible to the vertical.
  • Ensure that valves are not installed with the actuator at the bottom.

1520.50 DAMPERS:
Provide visual position indicators on all damper actuators installed so that they can be seen from the plantroom floor.
1600 COMMISSIONING

1600.010 GENERAL:
• Type
• Application
• Provide commissioning in accordance with CIBSE Commissioning Code C.
• Accept specification details required for commissioning in accordance with C3.2 of CIBSE Commissioning Code C

1700 DEMONSTRATION AND HANDOVER
Ensure that the system is tested and verified by the commissioning authority before proceeding with handing over.

1710 WITNESSING REQUIREMENTS:
• Type
• Application
Ensure that the project supervisor's nominated representative implements the following witnessing requirements. Ensure that on-site commissioning staff facilitate the witnessing process.
• Ensure that the BMS hardware is installed in accordance with the specification.
• Verify any operator software and associated graphics.
• Witness completely the control of any main and/or critical items of plant along with a random sample of other points.
  • If less than 300 points, witness all points. Between 300 and 1,000 points witness 50% (minimum of 300 to be witnessed). If more than 1,000 points witness 20% (with a minimum of 500 points witnessed).
  • Reserve the right to witness 100% of the points if the failure rate is greater than 5%.
• Witness a sample of specific functions, eg 10% of alarms and 10% of data logging.
• Witness one of several identical items of plant in detail with the others witnessed on a random basis.
• Verify the system security access.
• Verify that all safety-related functions perform to that specified, eg plant shutdown on fire condition.
• Verify all plant restarts according to that specified after building power failure and local power failure.
• Witness all power meter data-points to ensure that they match the meters.
• Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions.
• Verify the handover of all operating manuals and system documentation.
• Verify the handover of backup copies of software.
• Verify the completion of any specified system operator training.
1720 OPERATOR TRAINING:

- **Type**
- **Application**
- Ensure that training is completed and certificate of participation given before the BMS is handed over.
- Ensure that each trained operator signs a training acceptance certificate(s).
- Provide training off-site at the BMS suppliers training facility. Complement this off-site training with 'hands on' on-site training.
- Provide appropriate reference and training manuals for the operator.
- Provide operator training for one or more of the following levels of operator:
  - **Basic operator**
    - Ensure that the operator is trained to:
      - call up and view point-data from plant schematics and/or points lists
      - acknowledge system alarms
      - view trend logs.
  - **Intermediate operator**
    - In addition to the requirements for a Basic operator, ensure that the operator is trained to make basic alterations to the BMS including changes to:
      - time and occupancy programmes
      - control set-points
      - setting up trend logs
      - setting up alarm routines.
    - Ensure that the operator is also trained for testing and routine inspection of sensors and actuators.
  - **Advanced operator**
    - In addition to the requirements for an Intermediate operator, ensure that the operator is trained to:
      - add or change graphics/schematics
      - change control strategies
      - add analogue and digital inputs/outputs to the system
      - back-up the system and archive logged data
      - re-load system software/configuration details
      - add/modify passwords/monitor system security.

1730 OPERATION AND MAINTENANCE MANUALS:

- **Type**
- **Application**
  - Ensure that an initial draft of the O&M manual is submitted for approval prior to commissioning.
• Ensure that the O&M documentation is produced as the work proceeds and is updated when necessary. Ensure that this work commences at the start of the contract and is added to/updated as the contract progresses.
• Ensure that approved final copies of the O&M manuals are provided at handover.
• Ensure that the O&M manual is properly indexed. Ensure that terminology and references are consistent with the physical identification of component parts.
• Ensure that the O&M manual includes the following and is included in the site health and safety file:
  • a written description of plant operation
  • control strategy/logic diagrams recording the final version of configuration software installed at handover
  • details of system application software configuration
  • a points list including hard and soft-points (all points should have a unique mnemonic)
  • a description of user adjustable points
  • commissioning record details
  • detailed data sheets for all control components and equipment
  • wiring circuit details including origin, route and destination of each cable
  • basic security access to the system
  • comprehensive instructions for switching on, operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions
  • instructions for any precautionary measures necessary
  • instructions for the routine operation of the control system including simple day-to-day guidance for those operating the control system with limited technical skill
  • instructions for servicing and system upkeep
  • a provision for update and modification.
• Ensure that the O&M manual includes comprehensive system operating instructions.

1740 SOFTWARE
• Type
• Application
• Ensure that a copy of the configuration software is held both on and off-site.
• Ensure that, as alterations are made to the configuration software, all previous versions of the software are archived. Ensure that changes made to the software are recorded in the O&M manual with the reasons why changes were made.
• Ensure that all passwords are provided at handover.

1750 POST-HANDOVER CHECKS:
• Type
• Application
Ensure that the following post-handover checks are performed:
Global level checks
- internal air temperature
- relative humidity
- ventilation
- energy consumption (ensure that the pulse-input counters match the meters).

Check that each of the above meets the specified requirements.

System level checks
- Control strategies. Check that any suspect control strategies are appropriate for the intended application. Check that the suspect control strategy has been implemented and commissioned correctly. Check that the control strategy is still appropriate for the intended use.
- Network communications. Check that all relevant field controllers communicate properly. Check for correct sharing between controllers of relevant data and correct inter-controller operation.
- Control set-points. Check that the set-points in question are correct and appropriate for the actual operating conditions.
- Control loop settings. Check that the control loop settings result in accurate and stable control. Check that all self-learnt characteristics are valid.
- Control zones. Check that the control zones are appropriate.
- Occupant controls. Check that occupant controls work correctly.

Sub-system/component level
- Sensors. Check the accuracy and location of any suspect sensors.
- Actuators. Check that any suspect actuators operate correctly.
- Dampers and valves. Check that any suspect dampers and valves are not jammed and that they operate as intended.
BS APPENDIX

BS 1041-3:1989
Temperature measurement. Part 3 Guide to selection and use of industrial resistance thermometers

BS 21:1985
Specification for pipe threads for tubes and fittings where pressure-tight joints are made on the threads (metric dimensions).
   Partially superseded by BS EN 10226-1:2004

BS 4800:1989
Schedule of paint colours for building purposes

BS 5499-5:2002
Graphical symbols and signs. Safety signs, including fire safety signs. Part 5 Signs with specific safety meanings

BS 5584:1978
Specification for low voltage switchgear and controlgear for industrial use. Mounting rails. Top hat rails 35 mm wide for snap-on mounting of equipment

BS 5585:1978
Specification for low voltage switchgear and controlgear for industrial use. Mounting rails. Top hat rails 75 mm wide for snap-on mounting of equipment

BS 5954-2:1985
Dimensions of mechanical structures of the 482.6 mm (19 in) series. Part 2 Specification for cabinets and pitches of rack structures

BS 5954-3:1985
Dimensions of mechanical structures of the 482.6 mm (19 in) series. Part 3 Specification for subracks and associated plug-in units

BS 6701:2004
Telecommunications equipment and telecommunications cabling. Specification for installation, operation and maintenance

BS 7649:1993
Guide to the design and preparation of documentation for users of application software

BS 7671:2001
Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition
BS 7697:1993
Nominal voltages for low voltage public electricity supply systems

BS 7807:1995
Code of practice for design, installation and servicing of integrated systems incorporating fire detection and alarm systems and/or other security systems for buildings other than dwellings

BS 921:1976
Specification. Rubber mats for electrical purposes

BS EN 10213-1:1996
Technical delivery conditions for steel castings for pressure purposes. Part 1 General

BS EN 10213-2:1996
Technical delivery conditions for steel castings for pressure purposes. Part 2 Steel grades for use at room temperature and at elevated temperature

BS EN 10213-3:1996
Technical delivery conditions for steel castings for pressure purposes. Part 3 Steels for use at low temperatures

BS EN 10213-4:1996
Technical delivery conditions for steel castings for pressure purposes. Part 4 Austenitic and austenitic-ferritic steel grades

BS EN 10226-1:2004
Pipe threads where pressure tight joints are made on the threads. Part 1 Taper external threads and parallel internal threads. Dimensions, tolerances and designation

BS EN 1092-1:2002
Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 1 Steel flanges

BS EN 1092-2:1997
Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 2 Cast iron flanges

BS EN 1092-3:2003
Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 3 Copper alloy flanges
BS EN 1092-4:2002
Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Part 4 Aluminium alloy flanges

BS EN 12098-2:2001
Controls for heating systems. Part 2 Optimum start-stop control equipment for hot water heating systems

BS EN 12098-3:2002
Controls for heating systems. Part 3 Outside temperature compensated control equipment for electrical heating systems

BS EN 12163:1998
Copper and copper alloys. Rod for general purposes

BS EN 12164:1998
Copper and copper alloys. Rod for free machining purposes

BS EN 12167:1998
Copper and copper alloys. Profiles and rectangular bar for general purposes

BS EN 1561:1997
Founding. Grey cast irons

BS EN 1982:1999
Copper and copper alloys. Ingots and castings

BS EN 50160:2000
Voltage characteristics of electricity supplied by public distribution systems

BS EN 50174-1:2001
Information technology. Cabling installation. Part 1 Specification and quality assurance

BS EN 50174-2:2001
Information technology. Cabling installation. Part 2 Installation planning and practices inside buildings

BS EN 50174-3:2003
Information technology. Cabling installation. Part 3 Installation planning and practices outside buildings

BS EN 60073:2002
Basic and safety principles for man-machine interface, marking and identification.
Coding principles for indicators and actuators

BS EN 60127-2:2003
Miniature fuses. Part 2 Cartridge fuse-links

BS EN 60127-6:1994
Miniature fuses. Part 6 Fuse-holders for miniature cartridge fuse-links

BS EN 60269-1:1999
Low-voltage fuses. Part 1 General requirements

BS EN 60269-2:1995
Low-voltage fuses. Part 2 Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)

BS EN 60269-3:1995
Low-voltage fuses. Part 3 Supplementary requirements for fuses for use by unskilled persons (fuses mainly for household and similar applications)

BS EN 60269-4-1:2002
Low-voltage fuses. Part 4-1 Supplementary requirements for fuse-links for the protection of semiconductor devices. Sections I to III: Examples of types of standardized fuse-links

BS EN 60439-1:1999
Specification for low-voltage switchgear and controlgear assemblies. Part 1 Type-tested and partially type-tested assemblies

BS EN 60529:1992
Specification for degrees of protection provided by enclosures (IP code)

BS EN 60584-1:1996
Thermocouples. Part 1 Reference tables

BS EN 60584-2:1993
Thermocouples. Part 2 Tolerances

BS EN 60751:1996
Industrial platinum resistance thermometer sensors

BS EN 60947-3:1999
Specification for low-voltage switchgear and controlgear. Part 3 Switches, disconnectors, switch-disconnectors and fuse-combination units
BS EN 61508-1:2002
Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 1 General requirements

BS EN 61508-2:2002

BS EN 61508-3:2002
Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 3 Software requirements

BS EN 61508-4:2002
Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 4 Definitions and abbreviations

BS EN 61508-5:2002
Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 5 Examples of methods for the determination of safety integrity levels

BS EN 61508-6:2002

BS EN 61508-7:2002
Functional safety of electrical/electronic/programmable electronic safety-related systems. Part 7 Overview of techniques and measures

BS EN 61558-1:1998
Safety of power transformers, power supply units and similar devices. Part 1 General requirements and tests

BS EN 61800-1:1998
Adjustable speed electrical power drive systems. Part 1 Rating specifications for low voltage adjustable speed d.c. power drive systems

BS EN 61800-2:1998
Adjustable speed electrical power drive systems. Part 2 General requirements. Rating specifications for low voltage adjustable frequency a.c. power drive systems

BS EN 61800-3:2004
Adjustable speed electrical power drive systems. Part 3 EMC requirements and specific
test methods

BS EN 61800-4:2003
Adjustable speed electrical power drive systems. Part 4 General requirements. Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV

BS EN 61800-5-1:2003
Adjustable speed electrical power drive systems. Part 5-1 Safety requirements. Electrical, thermal and energy

BS EN 61810-1:2004
Specified time relays for industrial use. Part 1 Requirements and tests

BS EN 61812-1:1997
Specified time relays for industrial use. Part 1 Requirements and tests

BS EN 62208:2003
Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

BS EN 62262:2002
Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

BS EN 842:1996
Safety of machinery. Visual danger signals. General requirements, design and testing

BS EN 954-1:1997
Safety of machinery. Safety related parts of control systems. Part 1 General principles for design

BS ISO/IEC 17799:2005

BS ISO/IEC 27001:2005
Information technology. Security techniques. Information security management systems. Requirements
REFERENCES SPECIFICATIONS

AfDB: Electrical Specifications
Y45 SILENCERS/ACOUSTIC TREATMENT

1000 GENERAL
1010 PERFORMANCE:
Ensure that specified performance is met where protection is applied to infill to protect from moisture and grease.

1020 TESTING:
Provide certified insertion loss data in accordance with BS 4718. Provide generated sound power levels with insertion loss data. Where equipment is manufactured in modules ensure performance ratings apply to complete unit.

1030 PROTECTION:
Protect silencers where they are installed in positions exposed to external weather conditions. Block ends of silencers prior to delivery to site to prevent damage.

1040 DIRECTION OF FLOW:
Clearly mark direction of air flow on silencers.

2000 PRODUCT/MATERIALS
3010 GENERAL:
Install acoustic treatment equipment in positions indicated, in accordance with manufacturers instructions.

3020 ACOUSTIC ENCLOSURES:
Ensure that erection is carried out by enclosure manufacturer.

3030 ACCESS TO ACOUSTIC ENCLOSURES:
Provide door type openings in enclosures as required for access to items enclosed. Provide openings for inlet and discharge ductwork and for connections as indicated. Provide angle flange connections for mating to ductwork and equipment.

3040 SUPPORTS:
Supply steel section supporting frames or brackets where silencers are fixed to the walls of air chambers.

3050 ACOUSTIC LININGS:
Where personnel access is provided, protect acoustic linings to prevent damage.

3060 SOUND PRESSURE LEVEL READINGS:
Measure sound pressure levels at the positions indicated using equipment in accordance with IEC 179.

3070 BUILDING ELEMENT SOUND INSULATION READINGS:
Measure sound insulation of building elements in accordance with BS 2750 Parts 4 and 7 as appropriate.
1000 GENERAL

1010 DESIGN INTENT:
Supply equipment indicated to ensure that vibration from equipment is not transmitted to building, other supporting structure, pipework or ductwork.

1020 SPRING ANTI VIBRATION MOUNTINGS:
Select spring mounts with an overload capacity of 50%, for metal springs the outside diameter should be at least 75% of operating height. Permanently identify individual mounts with their load capacity.

1030 SPRING HANGERS:
Provide spring hangers that allow the lower hanger rod to move laterally at least 15°.

1040 LOCKING FACILITY:
Where indicated, provide lockable levelling device.

2000 PRODUCTS/MATERIALS

2010A SYNTHETIC MATERIAL CONFIGURED MAT MOUNTINGS:
Provide configured mat mountings manufactured from neoprene or composite fibre/synthetic rubber. Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010B NATURAL RUBBER CONFIGURED MAT MOUNTINGS:
Provide configured mat mountings manufactured from natural rubber. Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010C HIGH TEMPERATURE CONFIGURED MAT MOUNTINGS:
Provide configured mat mountings manufactured from high temperature synthetic rubber. Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010D RESILIENT MAT MOUNTINGS:
Provide a minimum of 20mm resilient mat and sheet of 1.6 mm steel for incorporation in cast in situ base.

2010E PAD MOUNTINGS:
Provide pad mountings manufactured from composite synthetic rubber.

2020A SYNTHETIC RUBBER TURRET COMPRESSION MOUNTINGS:
Provide turret compression mountings fabricated from synthetic rubber between two steel plates. Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.
2020B **NEOPRENE TURRET COMPRESSION MOUNTINGS:**
Provide turret compression mountings fabricated from neoprene between two steel plates. Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.

2030 **SPRING COMPRESSION MOUNTINGS:**
Provide spring compression mountings comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted on pre-drilled base for bolting down, and enclosed with cap. Protect metal from corrosion.

2040 **CAPTIVE SPRING MOUNTINGS:**
Provide captive spring mountings comprising high strength low stress helical spring designed to achieve horizontal and vertical snubbing. Mount spring on predrilled base plate for bolting down and protect against corrosion. Supply complete with levelling screw.

3010 **GENERAL:**
Install vibration isolation equipment and carry out levelling of equipment in accordance with manufacturer’s instructions.

3020 **CAST IN SITU BASES:**
Ensure bases are cast to achieve design static deflection.

3030 **FIXING:**
Fix down vibration isolation mountings only where indicated.

3040 **HORIZONTALLY RESTRAINED SPRING MOUNTINGS:**
Ensure snubbers for limiting excessive movement are installed out of contact during normal operation.
Y60 CONDUIT AND CABLE TRUNKING

1000 GENERAL

1010 STANDARDS:
Provide conduit and cable trunking in accordance with the relevant British Standards and in particular the requirements of BS 7671 Requirements for Electrical Installations (The IEE Wiring Regulations).

2000 PRODUCTS/MATERIALS

2030A CONDUIT - NON-METALLIC RIGID:
Material - Insulating conduit to BS 4607 Part 1.
Connections
Do not use slip joints. Use expansion couplings as required. Use solvent solution.

2060A CONDUIT FITTINGS AND ACCESSORIES - INSULATING TO BS 4607:
Conduit fittings and adaptable boxes
Do not use factory made bends, inspection bends or inspection couplers.
Use boxes and connections to suit size of conduit and method of jointing.
Use heavy gauge, high impact rigid PVC conduit fittings.
Provide all boxes for supporting luminaires or other heavy devices with metal brackets or insert clips to provide a support independent of the box.
Provide boxes for flexible conduit, accessories and luminaire connection with a brass earthing terminal and/or steel circular earthing ring.
Conduit fixing saddles - Spacer bar or hospital.
Plugs - Spout entry plug.

2080 CABLE TRUNKING AND FITTINGS:
Comply with BS 4678. Use trunking of each type from one manufacturer.

2110A SERVICE OUTLET BOXES:
Provide service outlet boxes and junction boxes constructed from sheet steel with same finish as trunking. Maintain continuity and segregation of compartments through boxes and fit flyovers where necessary.
Provide service outlet boxes with separate and segregated access to outlets associated with each wiring compartment. Fit cable guard or grommet to each section.
Incorporate spigots on boxes for connection to trunking.
Make frames adjustable on each corner, recess lids as indicated on drawings.
Manufacture frame and lids for service outlet boxes and junction boxes of cast metal, and suitable to accept type of floor covering.
Outlet plates
Provide outlet plates for each low voltage compartment equipped with socket outlets as scheduled or indicated on the drawings.
Provide outlet plates for each extra low voltage compartment equipped with items as scheduled or indicated on the drawings.
Provide outlet plates for each telephone compartment that ensure the telephone compartment and its outlet plate conform to the requirements of BT and of the telephone system installer, equipped with telephone outlets as scheduled or indicated on the drawings.

AfDB: Electrical Specifications
Provide blank outlet plates for any unused compartments.

2150A SEPARATE OR MULTI-COMPARTMENT TRUNKING:
Use separate trunking or multi-compartment trunking for segregation of services. Ensure steel partitions have a provision for connecting a circuit protective conductor.
Provide separation of wiring for circuits as required by BS 7671 and as indicated on the schedules or drawings.

2170 SUPPORTS AND FIXINGS:
Provide proprietary suspension systems comprising channel sections with return lips and compatible fixing accessories made of material to BS 2994 or BS 4848 and/or slotted angles to BS 4345.
Ensure support components for Class 4 conduit have the same finishing method as the conduit carried out after manufacture. Ensure components in direct contact with conduit match profile of conduit.
Ensure all steel components such as studding, bolts and steel screws, bolts, nuts and washers are either cadmium plated and passivated or zinc electroplated to BS 3382 after manufacture. Do not use metal fixing components likely to deteriorate and/or cause damage through electrolytic action.

3010A GENERAL:
Ensure entire system is electrically and/or mechanically continuous, to BS 7671.
Fire barriers
Comply with the requirements of BS 7671 wherever the conduit or trunking passes through the perimeter of a fire compartment (wall, floor or ceiling).
Appearance
Arrange conduit, trunking and ducting to present neat appearance, parallel with other service runs and lines of building construction, except where in screed or in-situ concrete. Ensure plumb vertical runs.
Cable installation
Install cable in conduit, trunking or equipment enclosures only when completely erected throughout its length.
Do not use framework of partitions or similar unless indicated.
Building expansion and settlement
Make provision in conduit and trunking at expansion and settlement joints to allow for movement of building structure. Provide circular through or adaptable boxes no more than 300 mm either side of expansion or settlement joints for conduit crossing.
Join boxes with flexible steel conduit type C or conduits arranged to form a telescopic joint and cover overall with PVC sleeve to provide minimum degree of protection of IP44 or purpose made telescopic joint protected by a PVC sleeve to at least IP44.
Quality
Cut conduit clean and square with axis. Remove any burrs prior to erection.
Site form 90° in conduit wherever practical or use circular or adaptable boxes.
Construct bends and sets cold with a bending machine. Do not apply heat when forming sets or bends.
Use bending tools complying with British Standards appropriate to conduit material.
Ensure no indentation or reduction in cross sectional area occurs during installation.
Use correct tools to assemble conduit. Ensure no tool marks or damage to components occurs.

AfDB: Electrical Specifications
3020 LAYOUT:
Ensure the maximum circuit lengths and groupings of cables indicated are not exceeded.
Conduit sizing
Where dimensions are not indicated select trunking and conduit sizes in accordance with Appendix A of Guidance Note I Selection and Erection published by the IEE.

3030 SPACING:
Install conduit, trunking and equipment clear of other services. Measure distance from external surface of any thermal insulation. Notify instances where minimum clearance cannot be achieved and bond items concerned.
Minimum general spacings between conduits, trunking and equipment and
- insulated steam services - 300 mm.
- other services excluding steam - 150 mm.
- above central heating radiators - 1000 mm.
Ensure separation is in accordance with Appendix K of Guidance Note I Selection and Erection published by the IEE.

3040 CONDENSATION PREVENTION:
Install conduit and trunking systems to ensure internal condensation does not affect operation of associated circuits. Provide drainage points in accordance with BS 7671.
Where conduit passes through external wall between two areas of different ambient temperatures or in other locations likely to cause condensation, install a conduit or adaptable box. After wiring fill box with inert, permanently plastic compound with high insulation value.

3050A PROTECTION AND REPAIR OF STEEL COMPONENTS:
Paint joints of conduit and minor damages to finish of conduit and trunking immediately after erection or after damage occurs.
Use paint compatible with finish as follows
- Galvanized finish, use two coats zinc rich paint.
- Black enamelled finish, use two coats of good quality, air drying, black enamel paint.
Remove grease, oil, dirt and rust before applying protective paint.
Notify serious damage and repair or replace as instructed.

3060 EQUIPMENT CONNECTIONS:
Where surface mounted equipment is installed in conjunction with concealed conduit work, terminate concealed conduit at flush mounted conduit or adaptable box. Drill back of equipment, bush for back entry and mount equipment to conceal back box.
Connect to fixed equipment via conduit box located adjacent to termination point, using either solid or flexible conduit as indicated for final connection to equipment terminations.
Use conduit box as cable change point to facilitate changed wiring locally to adjacent equipment.
Connect trunking to equipment by specially fabricated connectors or by couplers and externally screwed brass bushes.

3070 CLEANING BEFORE WIRING:
Clean inside of conduits and trunking with swabs immediately before wiring.
Inspect all components and remove any foreign matter, fit temporary plugs to open ends of conduit and trunking to prevent ingress of water and solid material.

AfDB: Electrical Specifications
3080A **WIRING:**

Comply with BS 7671 when wiring installations. Segregate circuits as indicated.

Ensure draw wires are left within empty conduits for use of specialist installers. Use draw wires comprising nylon tapes with fitted eyelets.

For concealed conduit ensure system is installed to enable re-wiring to be carried out from boxes for fittings or accessories only. Draw-in boxes will only be permitted with prior permission in writing.

Do not use tallow or any other substances to facilitate drawing-in of cables.

3090 **BUILDERSWORK:**

Ensure conduit is not concealed until work has been inspected and approved.

Obtain permission before horizontally chasing walls.

Ensure that conduit and fittings buried in concrete or behind plaster are protected against corrosion or electrolytic action prior to rendering.

Ensure conduit concealed in wall chases is covered by plaster and/or rendering to minimum depth of 12 mm.

4010 **DRAW-IN BOXES:**

Provide draw-in boxes in conduit at maximum intervals of 10 metres or after bends and/or sets totalling 180 degrees.

4020 **INSTALLATION OF CAST IN OR BURIED CONDUIT:**

Ensure cast-in conduits are firmly secured to reinforcing steelwork and that accessory and/or conduit boxes are secured so they do not move during subsequent building operations.

Ensure there is no blockage immediately shuttering is removed.

Check there is no mechanical damage to conduit in floor screed prior to screeding. Fix securely before screed is poured. Provide temporary protection to conduits until screeds are laid.

Ensure minimum amount of cross-overs occur dependent upon screed depth. Do not install draw boxes in floors.

Do not install conduits:

- in screeds in areas indicated.
- within site blinding.
- in main structural slabs unless prior permission in writing is obtained.

4030 **CONDUIT BOXES:**

Ensure that wherever conduit boxes are cast in the face of the box is flush with the face of the concrete or plaster. Fit circular conduit boxes with extension rings to ensure a flush face with plaster or concrete or where terminal blocks are to be accommodated.

Ensure fixing holes are countersunk where material thickness allows or use round head screws to prevent damage to cables and remove burrs before cables are drawn in.

Use a minimum of two screw fixing for standard circular conduit boxes and four screws for large conduit boxes and adaptable boxes up to 150 mm x 100 mm.

Use back outlet boxes where surface conduits pass through walls, to outside accessories or lighting points.

Secure switch boxes and socket boxes using countersunk steel screws where provision is made for them or if not use round head screws. Use plug inserts and finally grout in position prior to plastering or screeding.

AfDB: Electrical Specifications
4040 FIXING CONDUIT:
Support conduit in accordance with Appendix I of Guidance Note I Selection and Erection published by the IEE.
Ensure conduit is not under mechanical stress. Fix conduit boxes independently of conduit. Make allowance for any additional mechanical loading supported by conduit boxes.
Where protection is specified as IP44 or greater ensure fixings of conduit boxes are suitable to maintain degree of protection.
Use following methods of fixing conduit:-

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>TYPE OF FIXING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor screeds</td>
<td>Saddles or crampets</td>
</tr>
<tr>
<td>Buried in plaster</td>
<td>Saddles or crampets</td>
</tr>
<tr>
<td>or render</td>
<td></td>
</tr>
<tr>
<td>Above false ceilings</td>
<td>Saddles</td>
</tr>
<tr>
<td>Surface</td>
<td>Saddles</td>
</tr>
</tbody>
</table>

4050 FLEXIBLE AND PLIABLE CONDUIT:
Use flexible conduit for final connections to motors, other equipment subject to vibration or adjustment and to thermostats, motorised valves and similar items mounted in pipelines or ducts.
Use sufficient length between equipment and circular through box at end of conduit run (minimum 450 mm) to allow necessary full range of withdrawal, adjustment or movement.
Use solid type adapters to terminate flexible conduit.
Use PVC covered flexible conduit where installed externally, exposed to weather or in any position where ingress of moisture or condensation may occur.

4070A NON-METALLIC CONDUIT:
Comply with manufacturer’s instructions for bending, setting and jointing of conduit. Use plastic conduit only where indicated.
Do not install conduit when ambient working temperature is or will be below -5°C or above 60°C.
Use solvents recommended by manufacturer of conduit when using solvent welded joints and ensure spigots enter full depth of sockets. Hold joints rigid and in position until weld sets. Remove excess solvent before surface damage occurs.
Use slip joints as necessary, but not exceeding 6 metres on straight lengths to allow for expansion and contraction over temperature variation as indicated.
Use semi-mastic adhesive where expansion joints are formed.
Where fitments do not have shaped or smooth conduit entries connect with male bushes and external couplings.
Ensure special care is taken to prevent mechanical damage or warping to conduit where mechanical loads are imposed on conduit system, eg. lighting fittings.

5010 MANUFACTURE OF TRUNKING:
Take measurements on site before producing drawings for manufacture of trunking.

5020 ACCESS:

AfDB: Electrical Specifications
Arrange trunking to allow access to wiring. Locate covers on top or sides of trunking if practicable. Arrange access so covers are on a continuous face and cables can be laid in throughout the length of the trunking. Notify where either condition cannot be achieved.

5030A FIXING TRUNKING:
Ensure trunking is independently fixed and supported from building fabric. Obtain approval for proposed fixings/supports.
Support trunking in accordance with the manufacturers requirements and/or Guidance Note 1 Selection and Erection published by the IEE.
Use two fixings minimum per standard length.

5040A STEEL TRUNKING:
Install steel trunking in accordance with the manufacturers requirements and those of BS 7671.
Use trunking to avoid multiple parallel conduit runs, subject to approval.
Cut trunking clean and square with axis, prepare ends and remove burrs and sharp edges.
Ensure inside of trunking is free from anything liable to damage cables either during installation or after covers are fitted.
When trunking is held in a vice, ensure surfaces remain undamaged and components are not warped. Avoid tool marking or damage to trunking system components.
Do not site fabricate trunking tees, bends, flanges and other accessories. Use only factory made accessories.
Form circular holes over 6 mm diameter in trunking body using correctly sized punch sets. Use twist drill for holes up to 6 mm maximum diameter.
Use only factory formed openings for accessories.
Line unprotected apertures in trunking with PVC or nylon edging strip.
Fit ends of runs with removable blanking plates.
Ensure connections are not made to covers unless indicated or approval obtained.
Provide fixed section of cover projecting 25 mm either side of fabric where trunking passes through wall, floors or ceiling.
Fit cable retaining straps at 500 mm intervals except where cover is on top.

5050 UNDERFLOOR AND FLUSH FLOOR TRUNKING INSTALLATION:
Lay underfloor and flush floor trunking straight and level. Adjust height of services outlets, junction boxes and flush floor trunking to suit top of screed level. Ensure that spaces below trunking are free from voids and correctly packed. Prevent ingress of screed by masking where necessary.
Ensure trunking levelling and alignment is carried out in co-operation with person(s) responsible for confirming location and finish of floor levels.
Immediately following installation of trunking fit temporary covers to service outlets, junction boxes and flush floor trunking. Fit temporary blanking plates over open connections to vertical trunking. Retain temporary covers until permanent covers are installed.
Ensure underfloor trunking systems are fully rewirable to final circuit outlets.
Connect conduits only at inspection or other easy access points.
1000 GENERAL

1010 CABLE MANUFACTURE:
Use new cables, delivered to site with seals intact, manufactured not more than one year prior to delivery, labelled with manufacturer's name, size, description, BS number, classification, length, grade and date of manufacture.

1020 CABLE CERTIFICATION MARKING:
Mark all types of cable with CENELEC cable certification marking or if included in British Approvals Service for Electric Cables (BASEC) in accordance with BASEC regulations.

1030 MEDIUM VOLTAGE CABLE RECORDS:
Keep records of MV cable drum numbers and supporting information, mark information on record drawings, indicating precise location of each length of cable, and submit copies of manufacturer's cable test certificate.

2000 PRODUCTS/MATERIALS

2010D STANDARD ORDINARY FLEXIBLE CORDS - MULTI-CORE:
Standard BS 6007, Table 3 and Table 4; BS 6141, Tables 8, 10 and 15; BS 6500, Tables 6, 8, 16 and 18.

2020C STANDARD POWER SUPPLY CABLES, TPE INSULATION, SHEATHED:
Standard BS 6004, Tables 4 and 5; BS 6346, Tables 12, 14, 16, 18 and 20.
Mechanical protection - Unarmoured.

2020D STANDARD POWER SUPPLY CABLES, TPE INSULATION, SHEATHED AND ARMOURED:
Standard - BS 6346, Tables 12, 14, 16, 18 and 20.
Mechanical protection - Armour.

2020F STANDARD WIRES FOR CONDUIT AND TRUNKING, TPE INSULATED:
Standard - BS 6004, Tables 1(a) and 2.
Mechanical protection - Conduit and trunking.

2020L STANDARD CABLES REQUIRED TO MAINTAIN CIRCUIT INTEGRITY UNDER FIRE CONDITIONS:
Standard BS 6387; category, as shown on drawings/schedules.
Mechanical protection, as shown on drawings/schedules.

2030C STANDARD 11kV ARMOURED AND SHEATHED CABLES:
Standard - BS 6622, Tables 19 and 20.
Mechanical protection - Armour.
2070B STANDARD COMMUNICATIONS CABLES, FOR INDOOR USE:
Standard
BT CW 1308; BT CW 1370; BT CW 1700; and BT CW 1750.

2100A INFORMATION TECHNOLOGY CABLES - STRUCTURED WIRING:
Provide IT cables in accordance with the IT system supplier's specification.
Type of system - Structured cabling; EIA/TIA 568.
Specification - EIA/TIA 568; UTP (EIA/TIA TSB-36).
Termination reference
EIA/TIA 568; RJ45 (EIA/TIA TSB-40).
Cable construction - Multi pair; unshielded (UTP).

3010A CABLE GLANDS - UNARMOURED CABLES, INDOORS:
Cable type
Flexible; wiring and power; control and auxiliary; and communications.
Standard - BS 6121; Part 1, A1; Part 2, A1P.
Environment - Indoor.

3010B CABLE GLANDS - UNARMOURED CABLES, OUTDOORS:
Cable type
Flexible; wiring and power; control and auxiliary; and communications.
Standard - BS 6121; Part 1, A2; Part 2, A2P.
Environment - Outdoor.

3010C CABLE GLANDS - ARMOURED CABLES, DRY INDOORS:
Cable type
Wiring and power; and control and auxiliary.
Standard - BS 6121; Part 1, B; protection, W or Y.
Environment - Dry indoors.

3010D CABLE GLANDS - ARMOURED CABLES, INDOORS:
Cable type
Wiring and power; and control and auxiliary.
Standard - BS 6121; Part 1, D1; protection, W or Y.
Environment - Indoor.

3010E CABLE GLANDS - ARMOURED CABLES, OUTDOORS:
Cable type
Wiring and power; and control and auxiliary.
Standard - BS 6121; Part 1, E1; protection, W or Y.
Environment - Outdoor.

3030A VOLTAGE SURGE SUPPRESSORS FOR CABLES:
Provide voltage surge suppressors in accordance with cable and equipment manufacturer's recommendations.

3040A CABLE TERMINATING AND JOINTING SOCKETS:
Standard and type - compression to BS 4579, Part 1.
Connection type as shown on drawings/schedules.
3050C PVC INSULATING TAPE:
Standard - BS 3924, PVC.

3060A CABLE JOINTS AND TERMINATIONS:
Use only cable joints as supplied or recommended by cable manufacturer.
Cable type - Power or control and auxiliary.
Joint arrangement - Straight through or tee.
Joint type - BS 6910, cold pour or heat shrink.
Accessories - Armour bonds, BS 7197; filling compounds.
Environment - Underground.

3110A CABLE DUCTS:
Standard
BS 65, DN 90; BS 4660; or NJUG 6, provided by Electricity Supply Company.

3120A CABLE SLEEVES:
Supply and hand to others for installation non ferrous cable sleeves for incorporation into the structure where cables pass through fire compartment floors and walls.
Packing material
Weak mix mortar; intumescent, plaster or mastic; solid intumescent material; or intumescent granule filled bags.

3130A CABLE COVERS AND MARKERS:
Material - Recovered plastic, integral tape.
Marking - Electricity or telephone as shown on drawings/schedules.
Plastic marker tape
Yellow, marked electricity or telephone, as shown on drawings/schedules.

4010 CABLE INSTALLATION - GENERAL:
Use and install cables only as directed in the appropriate standard or as directed by the manufacturer in writing. Lay cables in one length unless otherwise indicated. Obtain permission from supervising officer for all through joints, and where overall length requirement exceeds practical drum size.
Install cables when ambient temperature is 5°C or greater, using cables stored at or above this temperature for not less than 24 hours.
Use drum stands, drum axles, fair leads, rollers, cable stockings and other equipment as recommended by the cable manufacturer and as appropriate to the method of installation.

4020 CABLE INSTALLATION IN LOW TEMPERATURES:
Install cables at lower installation temperatures when authorised by manufacturer in a written statement.

4040 INSTALLATION OF UNARMOURED CABLES:
Install and use unarmoured cable to BS 6004, BS 6007, BS 6141, BS 6500, BS 6726 and BS 7211 in accordance with BS 7540 or the manufacturers written instructions.

4050A CABLE TRENCHES:

AfDB: Electrical Specifications
Ensure that trenches for cables and cable ducts are prepared, backfilled and reinstated.

Supervise all work to cable trenches by others.

Carry out walk over survey of trench route, dig trial hole in any area considered to be potentially difficult. Establish locations of any other underground service adjacent to cable route.

Survey and Trial holes

Re-plan cable routes; submit report of survey and trial holes.

Carry out any instructed work to adjacent services. Set out cable trenches, excavate trench carefully setting aside any materials required for backfilling or reinstatement.

Minimum cover in cable trenches

HV cables 800mm; LV cables 500mm; communications cables 500mm; all cables 800mm under roadways.

Common trench for all underground services.

Grade trench bottom to a maximum slope of 1:12. Clear trench bottom of loose stones and place bedding to full width of trench.

Bedding

Riddled earth 6mm grid for cables; riddled earth 12mm grid for ducts; imported soft sand; or pea shingle, for ducts.

Bedding thickness - 75mm; or 100mm for ducts.

Install cables or ducts. Haunch cables or ducts in bedding material to a minimum depth of 75mm above highest cable or duct. Install cable or duct identification as indicated. Backfill trench using two layers 100mm thick hand rammed. Complete backfilling in layers as indicated. Reinstate trench as indicated.

Backfill material - as excavated from trench.

4060 CABLE INSTALLATION IN TRENCHES:

Lay cables on newly prepared bedding. Ensure multiple layers of cable are separated vertically by a 50mm layer of hard rammed bedding material.

When using a power winch ensure tension on the cable is taken by element of the cable designed for that purpose, that is armour or conductor cores as appropriate and not plastic sheath, metal sheath or core insulation.

During hand pulling cable ensure no kinks are formed and that flaking when used is done in the correct direction.

Do not allow cable to twist during installation. Use swivels to connect pulling bond to cable stocking or equivalent fitting.

Check drum is suitable for jacking before commencing installation. If drum or reel is unsuitable for jacking, flake cable in correct direction in maximum size turns from drum or reel before commencing installation. Use skilled labour to supervise all unreeling, flaking or running of cable from a drum.

Lay cables in the formation shown, ensure spacing is not reduced below that indicated.

Bind trefoil groups at 1m intervals. Bind any associated earth or protective conductor to its cable or trefoil group at 1m intervals.

Ensure installation radii and permanent bending radii are not less than those recommended by the manufacturer.

Do not lay cables to BS 6004, BS 6007, BS 6141, BS 6500, BS 6726 or BS 7211 direct in the ground.

Cable in trenches should be protected with concrete slabs. In addition, warning tapes are also to be provided.

4070A CABLE DUCTS:

Duct work

AfDB: Electrical Specifications
Supervise the laying of ducts by others. Lay ducts, jointed in accordance with the manufacturer’s instructions, in the formation shown on to newly prepared bedding.
Ensure that ducts slope no more than 1:60 vertically or 1:30 horizontally.
Ensure that pre-formed duct bends used at ends of duct routes meet the requirements of the cable manufacturer for bending radii.
Construct manholes, draw pits and jointing chambers as indicated.
Prove alignment of completed duct run by drawing through a mandrel of diameter 7mm less than nominal duct bore of minimum length 250mm. Clean completed duct run by drawing through a circular wire brush of diameter 12mm more than nominal duct bore.
Install in each empty duct a draw wire of corrosion resistant material of minimum breaking strength 550N.
Plug and seal all ducts on completion with proprietary duct plugs.

4080 CABLE INSTALLATION INTO DUCTS:
Prove and clean ducts using a mandrel of diameter 7mm less than nominal duct bore a minimum of 250mm long and a wire brush of diameter 12mm more than nominal duct bore.
Install cables into newly proved and cleaned duct. Use lubricants, recommended by the cable manufacturer in writing, to assist drawing process.
Flake cable from drums or reels not suitable for jacking. Flake cable where necessary at intermediate draw pits before entering cable into exit duct more than 15° off line of entry duct or provide comprehensive system of corner plates, roller and blocks. Use the maximum practical size of turns when flaking and ensure direction of flake is correct.
Do not exceed manufacturer’s installation tension on cable and ensure the pulling tension is taken on cable elements designed for that purpose, that is armour or conductor cores and not on other elements, such as plastic sheath or conductor insulation.
Do not allow cables being pulled into ducts to twist. Use appropriate swivel between pulling bond and cable stocking or similar appliance.
Bind trefoil groups of single core cables installed into a single duct at 1m intervals. Install earth or protective conductors into the same duct as the associated cable where practical, binding the two together through manholes, draw pits and jointing chambers. Pull all cables in one duct as a group. Ensure the group does not twist or cross over. Report any damage to cable sheath during installation and carry out any instructed work to remedy the damage.
Seal between cable and duct ends after cable installation. Ensure cable ends in jointing chambers are temporarily sealed where required.

4090A CABLE INSTALLATION IN CONDUIT AND TRUNKING:
Install cables so that they are orderly and capable of being withdrawn.
Arrange single core wiring generally using the loop-in method.
Trunking
In vertical trunking provide pin racks at 3m intervals. Use ties for all wires of the same circuit reference at 2m intervals. Mark ties at 10m intervals with circuit reference number.
Conduit
Provide cable clamps in conduit boxes at 10m intervals in vertical conduit. Allow for full range of movement at building construction movement joints. Make all joints to wiring at terminal blocks in conduit boxes.

4100 CABLE INSTALLATION ON TRAY AND RACK:
Place cables side by side or as indicated, fix using cleats or cable ties so that any cable may be individually removed.

AfDB: Electrical Specifications
4110A CABLE SURFACE INSTALLATION:
Dress cables flat, free from twists, kinks and strain, and align parallel to building elements. Take sheathing of cables when glands and clamps are not required into accessory boxes and equipment and protect against abrasion using grommets or similar sharp edge protection. Clearance as shown on drawings/schedules.

4120A CABLE EMBEDDED INSTALLATION:
Install embedded cables as for surface installation. Ensure plaster or screed over cable is a minimum of 12mm. Protect embedded cables with metal capping or PVC oval conduit.

4140 CABLE INSTALLATION - FLEXIBLE CORDS:
Grip cords securely at connections. Where they do not form an integral part of the connected accessory or equipment, provide separate proprietary cord grips.

4150A CABLE JOINTING AND TERMINATING GENERALLY:
Ensure all joints and terminations are made by appropriately qualified cable jointers, using jointing materials, components and workmanship recommended by the cable manufacturer and the jointing accessory manufacturer. Install cable glands in accordance with BS 6121 Part 5.
Cold pour resin and heat shrink joints in accordance with BS 6910 Part 2.
Cut all cable ends immediately prior to jointing or terminating. Seal cables left unconnected for more than 24 hours to prevent the ingress of moisture.
Seal plastic sheathed cables using proprietary shrink on end caps. Seal lead sheathed cables by a plumbed dressed lead cap with an air space to allow conductor movement.
Strip cables to bring out the cores and expose conductors, for the minimum length required for connection, to leave no exposed length of conductor after termination. Ensure that strands are not damaged when stripping cable cores. Twist strands together. Do not reduce number of strands. Secure all strands at terminations.
Clean armour thoroughly prior to jointing or terminating.
At connections to equipment and switchgear without integral cable clamping terminals, use compression or solder type lugs for bolted terminal connections, of correct bore.
Form all compression connections to components using tools that can not be released unless the correct degree of compression has been achieved.
Install and inspect compression and mechanical connectors on conductors in accordance with BS 6360 to BS 7609.
Bolt core terminations with lugs to equipment using washers or proprietary shakeproof devices.
Do not bunch more than three cores at clamping terminals or bolted connections.
Mark cable conductor phasing, or other core identification, at each end of all cables, and at all joints, maintaining consistency of marking with any existing system.
Connect all cores, including multicore cable spare cores, at all joints and terminations. Bond any unused cores of multicore cables to earth at both ends, unless otherwise indicated.

4200 CABLE SLEEVES:
Pack sleeves with fire resistant material after cable installation.
1000 GENERAL

1010 APPLICATION:
Cables referred to in this section are only those types that can be installed without further mechanical protection.

2000 PRODUCTS/MATERIALS

2020A CABLE SUPPORT SYSTEM - PERFORATED TRAY:
Type - Flanged or return flanged.
Perforations
Admiralty pattern for light or medium duty; GDCD pattern standard 23; or manufacturer’s standard pattern.
Thickness - Manufacturer's standard thickness for type.
Fittings
Use factory made fittings throughout of same material, type, pattern, finish and thickness as cable tray.
Use reducers, inside angles and outside angles as manufacturer's standard.
Use flat bends, equal tees, unequal tees and crosses with corners gusseted.
Join lengths of tray and fittings using manufacturer's standard shouldered ends, fish plates, or couplers, with galvanized or zinc plated slotted domed head 'roofing' bolts, nuts, washers and shakeproof washers.
Material
Hot rolled steel galvanized after manufacture to BS 729; or bending and profiling quality hot dipped galvanized steel to BS EN 10142 or BS EN 10143 and BS EN 10147.
Finish - Self colour galvanized.

2020B CABLE SUPPORT SYSTEM - CABLE RACK:
Proprietary system of channel sections with return lip and compatible jointing and fixing accessories
Fittings
Use factory made fittings throughout of same material finish and section as rack, for risers, bends, reducers, tees, crosses and drop outs.
Material
Hot rolled steel galvanized after manufacture to BS 729; or bending and profiling quality hot dipped galvanized steel to BS EN 10142 or BS EN 10143 and BS EN 10147.
Finish - Self colour galvanized.

2020C CABLE SUPPORT SYSTEM - CABLE CLEATS:
One piece or single way pattern or claw pattern or two bolt pattern.
Material
Die cast aluminium alloy; moulded black polyethylene; or nylon.
Finish - Self finish.

2020D CABLE SUPPORT SYSTEM - PROPRIETARY CABLE TIES:
Two piece cable tray pattern, on cable tray only. Wrap round self locking non releasable pattern on everything except cable trays.

AfDB: Electrical Specifications
2020E  CABLE SUPPORT SYSTEM - CABLE CLIPS:

Polypropylene surface type with pre-fixed hardened steel pin for general use except on mineral insulated cables.
For mineral insulated cables use bright copper one hole `P'clips for unsheathed mineral insulated cables, TPE covered for sheathed mineral insulated cables.

2020F  CABLE SUPPORT SYSTEM - TWO WAY SADDLES:

Bright copper for unsheathed mineral insulated cables. TPE covered bright copper for sheathed mineral insulated cables.

3010  CABLE TRAY INSTALLATION:

Support from building fabric with minimum clearance behind of 20mm. Install fixings at regular intervals to prevent visible sagging when loaded, with maximum spacing 1.2m and 230mm from fittings.
Keep cutting of cable tray to a minimum. Cut along a line of unperforated metal. Make good finish with zinc rich paint, primer and top coat, or two pack epoxy paste, as appropriate to tray material and finish.
Fit holes cut in tray for passage of cables with grommets, bushes or other lining. Install all bolts, fixings and hangers with threaded portion away from cables.

3020A  CABLE CLEATS, TIES, SADDLES AND CLIPS INSTALLATION:

For cables on horizontal tray use ties for each circuit. Use tie manufacturer's special tensioning tool where available. Crop off tie ends.
For cables on vertical tray use cleats bolted to tray for paper, plastic or elastomeric insulated cables and saddles or clips for mineral insulated cables. Use cleats sized to grip cables firmly without undue pressure or strain on cable, but preventing slipping.
For cables on vertical or horizontal rack use proprietary fixings to rack for paper, plastic or elastomeric insulated cables and saddles or clips for mineral insulated cables.
On continuous flat surfaces of wood, plaster, brick etc.
Use polypropylene surface fixing clips with pre-fixed hardened steel pin for TPE insulated and sheathed cables and sheathed or bright mineral insulated cables. Use round or flat or flat twin pattern as appropriate, manufactured specifically for cable being fixed.
Use one hole `P' clips or two way saddles of bright copper for unsheathed mineral insulated cable. Use TPE covered for sheathed mineral insulated cables.
Space cleats, ties, saddles and clips
As Appendix I of Guidance Notes `Selection & Erection' published by the IEE.
28/05/13

Y71 LV SWITCHGEAR AND DISTRIBUTION BOARDS

1000 GENERAL

2000 PRODUCTS/MATERIALS

2040A TYPE TESTS:
Provide certificates of verification.

2050# ROUTINE TEST:
  Carry out test on site.
  Repeat test on site.

2200A FUSES:
Supply cartridge fuse links including fuse carrier, bases and associated components that comply with BS 88 (BS EN 60269), fusing factor category gG, unless otherwise indicated.
Use motor circuit fuses as shown on drawings/schedules.

2240A RESIDUAL CURRENT DEVICE:
Comply with BS 4293. Supply residual current devices (RCDs) with rated voltage, rated current, rated trip current, rated tripping time and rated breaking capacity as shown on drawings/schedules.
DC component
  Ensure dc component does not affect operation.
Overcurrent protection
  Fit RCDs with integral overcurrent protection.

3010 FIXING:
Fix all equipment independently of wiring system. Use cadmium or zinc electroplated bolts, nuts, washers and screws.

3020 MOUNTING HEIGHT:
Mount single items of equipment 1450mm above finished floor level to centre of equipment, unless shown otherwise on drawings/schedules.
Arrange groups of equipment, other than floor mounted assemblies, so that all parts of equipment requiring access for operation or maintenance are at least 500mm and no more than 2000mm above finished floor level, unless shown otherwise on drawings/schedules.

3030 ACCESS:
Ensure that clearance in front of switchgear and controlgear is not less than 1m, or as indicated.

3050 CABLE TERMINATIONS:
Terminate paper-insulated cable by means of switchboard manufacturer's standard compound filled cable boxes.
Terminate PVC SWA PVC and MICS cables inside enclosure by securing cables to switchboard with glanding plates or glanding brackets; and outside enclosure with glanding plates or fabricated steel extension boxes.

AfDB: Electrical Specifications
Y73 LUMINAIRES AND LAMPS

1000 GENERAL

1010 STANDARDS:
Supply luminaires and lamps to standards as appropriate.

2000 PRODUCTS/MATERIALS

2010A LUMINAIRES - GENERAL PURPOSE:
Standards
Supply luminaires with photometric data in accordance with BS 5225.
Supply luminaires in accordance with BS 4533 (EN 60598).
Classification - To BS 4533 Part 101 (EN 60598-1).
Safety Support for Components
Provide secondary support for translucent covers, diffusers and gear trays so they are prevented from falling when their primary fixing is released.
Photometric performance
Ensure luminaires of similar type have same photometric performance as published data within the tolerances defined by BS 5225.

2010C LUMINAIRES - SPECIAL APPLICATIONS:
Standards
Supply luminaires with photometric data in accordance with BS 5225.
Supply luminaires in accordance with BS 4533 (EN 60598).
Classification - To BS 4533 Part 101 (EN 60598-1).

2020A EMERGENCY LIGHTING LUMINAIRES:
Comply with BS 4533 Section 102.22 (EN 60598-2-22).
Comply with ICEL:1001. Ensure emergency lighting luminaires are marked with ICEL certification label.

2030 EXIT SIGNS:
Comply with BS 5499 Parts 1 & 3.

2060 LAMPHOLDERS - GENERALLY:
Lamp caps - BS EN 60061-1.
Lamp holders - BS EN 60061-2.
Bayonet lampholders - BS 5042.
Lampholders for tubular fluorescent lamps and starterholders - BS EN 60400.
Edison screw lampholders - BS EN 60238.
Interchangeability
Ensure lampholders in luminaires of similar type and rating are identical.
Earthing
Ensure metal lampholders incorporate an earthing terminal.
2070 LAMPHOLDERS - TUNGSTEN FITTINGS:
Use following lampholders for tungsten filament lamps unless indicated otherwise.

<table>
<thead>
<tr>
<th>Lamp</th>
<th>Lampholder</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 150W</td>
<td>bayonet B22d</td>
</tr>
<tr>
<td>200W</td>
<td>edison screw E27 2A</td>
</tr>
<tr>
<td>300W and above</td>
<td>edison screw 16A</td>
</tr>
</tbody>
</table>

Shade Rings
Provide a shade carrier ring for separately mounted lampholders for GLS tungsten filament lamps.

Polarity of Edison Screw Lampholders
Ensure phase conductor is connected to centre contact.

2080A LAMPHOLDERS - MOUNTING:
Securely mount lampholder in luminaire when it is sole support for lamp.

Cord grip
Provide integral cord grip type when lampholders are suspended by cord.

Conduit Mounted
When mounted directly to conduit system use backplate lampholder for conduit box.

2090A CONTROL GEAR AND COMPONENTS
Compatibility
Ensure control gear and components are suitable for lamp type, wattage and starting characteristics.
Obtain from manufacturers written confirmation of compatibility.

2100A FLUORESCENT LAMP BALLASTS AND STARTERS:
Ballasts
BS EN 60920 and BS EN 60921.
BS EN 60924 and BS EN 60925 for d.c. supplied electronic ballasts.
BS EN 60928 and BS EN 60929 for fluorescent lamps to BS 1853 Part 1 (EN 60081) and BS 6982 (EN 60901).
Supply thermal protectors for ballasts for tubular fluorescent lamps to BS EN 60730-2-3.
Starters - BS EN 60926 and BS EN 60927.
Use low distortion type.

2110A DISCHARGE LAMP BALLASTS AND STARTERS:
Ballasts - BS EN 60922 and BS EN 60923.
Starters - BS EN 60926 and BS EN 60927.

2120A CAPACITORS:
Use capacitors in accordance with BS EN 61048 and BS EN 61049 in tubular fluorescent, high pressure mercury and low pressure sodium vapour discharge lamp circuits.

2130 SUPPLY TERMINALS:

AfDB: Electrical Specifications
Use screw terminals for supply cables and circuit protective conductors, sized to terminate up to three 2.5mm² conductors. Provide separate terminal blocks for each incoming circuit, with marking to identify each circuit.

2140 FUSE:
Include a fuse holder and BS 1362 fuse in each incoming circuit phase connection.

2150 INTERFERENCE:
Comply with BS EN 55015 and BS 5394.

2160 REMOTE GEAR:
Locate control gear in separate lockable cabinet of sheet steel with same degree of protection and finish specified for luminaire. Comply with manufacturer’s recommendations for maximum cable length between gear and lamp.

2170A TUNGSTEN FILAMENT LAMPS:
Comply with BS 161 (EN 60064), BS 5971 (EN 60432) and BS 6179.
Supply electronic step-down converters for filament lamps to BS EN 61046 and BS EN 61047.

2180A FLUORESCENT LAMPS:
Internationally specified tubular fluorescent lamps to BS EN 60081.
UK tubular fluorescent lamps to BS 1853 Part 2.
Single capped fluorescent lamps to BS EN 60901 and BS EN 61199.
Self ballasted lamps to BS EN 60969 (BS 7199) and BS 7173 (EN 60968).

2190 HIGH PRESSURE MERCURY VAPOUR LAMPS:
Comply with BS 3677 (EN 60188).

2200 HIGH PRESSURE SODIUM VAPOUR LAMPS:
Comply with BS EN 60662.

2210 LOW PRESSURE SODIUM VAPOUR LAMPS:
Comply with BS EN 60192.

2230 LAMP MANUFACTURER:
Ensure that lamps of each type are from same manufacturer.

2240A SUPPORT SYSTEM - CONDUIT:
Use not less than 20mm conduit of same type as main conduit system.
Material - steel.

2250A SUPPORT SYSTEM - ROD:
Use continuously threaded rods with matching washers and nuts.
Diameter - 6mm. Material - Cadmium plated steel.

2260A SUPPORT SYSTEM - CHAIN:
Use cadmium plated steel chain with load carrying capacity of not less than twice weight of complete luminaire.

2270A SUPPORT SYSTEM - FLEXIBLE CORD:
Use size and type as indicated on the drawings/ schedules.
Confirm temperature rating is suitable for operating temperature of luminaire or lampholder.
Confirm that cord is adequate for mass to be supported.

**2280A SUPPORT SYSTEM - WALL BRACKETS:**
Provide wall brackets. Confirm wall brackets are suitable for supporting luminaire.

**3010 TRACK LIGHTING:**
Where indicated provide track for fixing fittings in accordance with BS EN 60570.

**3020 INTEGRAL PHOTO-CELLS:**
Incorporate integral photo-cell on luminaire where indicated.

**4010 ORIENTATION:**
Install luminaires as indicated on drawings/schedules, and in horizontal plane unless otherwise indicated.

**4020 CLEANLINESS:**
Ensure luminaires are clean and grease free on handover.

**4030 INSTALLATION OF RECESSED FITTINGS:**
Install luminaires flush with finished ceiling level.

**4040A INSTALLATION OF SEMI-RECESSED FITTINGS:**
Install luminaires as manufacturer's detail.

**4050 INSTALLATION OF WALL MOUNTED FITTINGS:**
Install luminaires at height indicated.

**4060 MATERIAL OF SUPPORTING SURFACE:**
Ensure classification of luminaires is appropriate. Do not mount luminaires on readily flammable surfaces.

**4080 LUMINAIRES IN AREAS WITH INFRA-RED CONTROL SYSTEM:**
Install luminaires in areas with infra-red control systems or data bearers so as to cause minimum disturbance to the infra-red transmission system in accordance with BS 7693.

**4100 INSTALLATION OF EXTRA LOW VOLTAGE TUNGSTEN HALOGEN LAMPS:**
Use same wattage lamp on luminaires fed from common transformer. Supply each luminaire on common transformer by separate cable of same cross-sectional area.
4110  SUPPORT
Ensure support is adequate for weight of luminaires.
Number
  Provide the following minimum number of supports for each luminaire longer than 600mm.
  Luminaire Width(mm)    Minimum number of supports

  Up to and including 300  2
  Over 300                 4

4120  SUPPORT FROM CONDUIT:
Where luminaire is supported from conduit provide a conduit box forming an integral part of conduit system at each point of suspension. Ensure suspensions are vertical.
Where conduit enters luminaire use back-nuts and washers to secure luminaire body to conduit support. Provide tube with corrosion resistance equal to conduit system.
Do not support luminaires directly from conduit boxes made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60°C or the mass suspended exceeds 3kg.

4130  SUPPORT FROM TRUNKING:
Where luminaire is supported from trunking use proprietary clamps or brackets appropriate to the luminaire and trunking.
Do not support luminaires directly from trunking made from non-metal or heat sensitive materials, where the temperature of the material may exceed 60°C or the mass suspended exceeds 3kg.

4140A  SUPPORT BY DIRECT FIXING:
Refer to fixing methods
  Luminaire supporting coupler to BS 7001 or as manufacturers recommendations.

4150A  SUPPORT IN SUSPENDED CEILING:
Support luminaires directly from building fabric.

4160  SUSPENSION:
Suspend luminaires at height indicated. Ensure suspensions hang vertically unless otherwise indicated.

4170  SUSPENSION BY ROD:
Use washers, nut and lock-nut at top and bottom of rod. Paint cut ends with calcium plumbate primer or zinc rich paint.

4180  SUSPENSION BY CHAIN:
Use hook cover for suspension from circular conduit box. For connection to luminaires use luminaire manufacturer's own chain hook, but if not available use hook with standard screw threaded body to be secured to luminaire body with nuts and washers. Where indicated use captive hooks.

4190  SUSPENSION BY FLEXIBLE CORD:
Suspend cord from ceiling rose.
4220 CONNECTIONS TO LUMINAIRES
Cable Protection
Use appropriate size of grommet where cables enter through hole in luminaire body.
Earthing
Ensure that the earthing terminal of Class 1 luminaires is connected to the conduit protective conductor of the supply circuit.
Loose Wiring
Clip or tie back with suitable proprietary devices loose wiring within luminaire, at 300mm intervals.

4230A CONNECTIONS TO LUMINAIRES - DIRECT TO CONDUIT - TERMINAL BOX:
Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cord from terminal block to luminaire.

4230B CONNECTIONS TO LUMINAIRES - DIRECT TO CONDUIT - AT LUMINAIRE:
Terminate circuit wiring at supply terminals of luminaire. Take all conductors through same cable entry into luminaire.

4240A CONNECTIONS TO LUMINAIRES - DIRECT TO TRUNKING - TERMINAL BOX:
Terminate circuit wiring in terminal block in an adaptable box located on side of trunking. Use flexible cord from terminal block to luminaire.

4240B CONNECTIONS TO LUMINAIRES - DIRECT TO TRUNKING - AT LUMINAIRE:
Terminate circuit wiring at supply terminals of luminaire. Take all conductors through same cable entry into luminaire.

4250 CONNECTIONS TO LUMINAIRES - SUSPENDED FROM TRUNKING:
Where luminaires are suspended from trunking, secure plug and socket to BS 546, adjacent to, or on side of, trunking. Terminate circuit wiring at socket. Take flexible cord from plug of ceiling rose to supply terminals of luminaire.

4260A CONNECTIONS TO LUMINAIRES - RECESSED FITTINGS - PLUG AND SOCKET:
Where luminaires are recessed in a suspended ceiling, terminate circuit wiring in terminal block within conduit box. Install wiring to luminaire as indicated on drawings.

4260B CONNECTIONS TO LUMINAIRES - RECESSED FITTINGS - TERMINAL BOX:
Where luminaires are recessed in a suspended ceiling, terminate circuit wiring in terminal block within conduit box. Install wiring to luminaire as indicated.

4270 CONNECTIONS TO LUMINAIRES - CONDUIT SUSPENSION:
Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cable from terminal block to luminaire, installed within tube.

4280 CONNECTIONS TO LUMINAIRES - ROD OR CHAIN SUSPENSION:
Terminate circuit wiring in terminal block within supporting conduit box. Use flexible cord from terminal block to luminaire and clip cable to one of the rods or chains, do not weave cable through links of the chain.
4300A  SEPARATE LIGHTING SWITCHES ON DIFFERENT PHASES:
Install lighting switches on different phases at least 2m apart.

4300B  PHASE BARRIER LIGHTING SWITCHES ON DIFFERENT PHASES:
When lighting switches on different phases are in a common box, use phase barrier switches.
Y74 ACCESSORIES FOR ELECTRICAL SERVICES

1000 GENERAL

1010 APPLICATION:
Supply fixed electrical wiring accessories for use with fixed and portable peripheral equipment using either power or signalling cables.

1020 SAMPLES:
Where indicated submit samples of proposed materials and equipment for approval before work is started. Label each sample with name, catalogue number and services in connection with item.

2000 PRODUCTS/MATERIALS

2010A ACCESSORIES COMMON REQUIREMENTS - WHITE PLASTIC PLATES, FLUSH INSTALLATION:
Area of installation - Interior.
Enclosure pattern - Flush.
Accessory mounting
   Adjustable steel grid for grid switches or direct to enclosure for all other accessories.
Enclosure material - Pressed steel.
Enclosure finish - Galvanized.
Coverplate finish, all accessories to match
   Moulded plastic, colour - white.
Coverplate pattern
   Overlapping; with architrave where indicated on drawings/schedules.
Ancillaries
   Earthing terminal integral within switch box.
   Neon indicator with red lens, illuminated in ‘ON’ position, for connection units.
   Switch rocker bar colour - white.
   Operating keys for key operated switches, minimum number 2.
   Fuses to BS 1362 as shown on drawings/schedules.
   Blank inserts for spare ways on grid switches.
Marking
   Method - engraving. Mark front plate to indicate equipment served on connection units.
Conduit and cable entries
   Knockouts side, top and rear.
Cable termination - Manufacturer’s standard.

2010B ACCESSORIES COMMON REQUIREMENTS - METAL PLATES, FLUSH INSTALLATION:
Area of installation - Interior.
Enclosure pattern - Flush.
Accessory mounting
   Adjustable steel grid for grid switches or direct to enclosure for all other accessories.
Enclosure material - Pressed steel.
Enclosure finish - Galvanized.
Coverplate finish, all accessories to match
  Brass with matt chrome surface or brass with BMA/bronze surface as indicated on the
drawings/schedules.
Coverplate pattern
  Overlapping; with architrave where indicated on drawings/schedules.
Ancillaries
  Earthing terminal integral within switch box.
  Neon indicator with red lens, illuminated in 'ON' position, for connection units.
  Switch rocker bar colour as shown on drawings/schedules.
  Operating keys for key operated switches, minimum number 2.
  Fuses to BS 1362 as shown on drawings/schedules.
  Blank inserts for spare ways on grid switches.
Marking
  Method - engraving. Mark front plate to indicate equipment served on connection units.
Conduit and cable entries
  Knockouts side, top and rear.
Cable termination - Manufacturer's standard.

2010C ACCESSORIES COMMON REQUIREMENTS - WHITE PLASTIC PLATES, EMBEDDED CABLES, SURFACE INSTALLATION:
  Area of installation - Interior.
  Enclosure pattern - Surface.
  Accessory mounting - Direct to enclosure.
  Enclosure material - White moulded plastic.
  Coverplate finish, all accessories to match
    Moulded plastic, colour - white.
  Coverplate pattern - Surface type.
Ancillaries
  Earthing terminal integral within switch box.
  Neon indicator with red lens, illuminated in 'ON' position, for connection units.
  Switch rocker bar colour as shown on drawings/schedules.
  Operating keys for key operated switches, minimum number 2.
  Fuses to BS 1362 as shown on drawings/schedules.
Marking
  Method - engraving. Mark front plate to indicate equipment served on connection units.
Conduit and cable entries
  Knockouts side, top and rear.
Cable termination - Manufacturer's standard.

2010D ACCESSORIES COMMON REQUIREMENTS - METAL CLAD PLATES, SURFACE STEEL CONDUIT INSTALLATION:
  Area of installation - Interior.
  Enclosure pattern - Surface.
  Accessory mounting - Direct to enclosure.
  Enclosure material
    Pressed steel or cast iron.
  Enclosure finish
    As conduit system or galvanized.
Coverplate finish, all accessories to match

AfDB: Electrical Specifications
Metal clad.

Coverplate pattern - Surface type.

Ancillaries

Earthing terminal integral within switch box.

Neon indicator with red lens, illuminated in 'ON' position, for connection units.

Switch rocker bar colour as shown on drawings/schedules.

Operating keys for key operated switches, minimum number 2.

Fuses to BS 1362 as shown on drawings/schedules.

Marking

Method - engraving. Mark front plate to indicate equipment served on connection units.

Conduit and cable entries

Threaded entries, top, bottom or side to suit conduit system.

Cable termination - Manufacturer's standard.

2010E ACCESSORIES COMMON REQUIREMENTS - SURFACE, STEEL CONDUIT, WEATHERPROOF INSTALLATION:

Area of installation - Exterior.

Enclosure pattern - Surface and weatherproof.

Accessory mounting - Direct to enclosure.

Enclosure material - Cast iron.

Enclosure finish - As conduit system or galvanized.

Coverplate finish, all accessories to match as enclosure.

Coverplate pattern - Surface type.

Ancillaries

Earthing terminal integral within switch box.

Neon indicator with red lens, illuminated in 'ON' position, for connection units.

Screwed weathering cap and chain for socket outlets.

Operating keys for key operated switches, minimum number 2.

Fuses to BS 1362 as shown on drawings/schedules.

Marking

Method - engraving. Mark front plate to indicate equipment served on connection units.

Conduit and cable entries

Threaded entries, top, bottom or side to suit conduit system.

Cable termination - Manufacturer's standard.

2010F ACCESSORIES COMMON REQUIREMENTS - SURFACE, PLASTIC, WEATHERPROOF INSTALLATION:

Area of installation - Exterior.

Enclosure degree of protection to BS EN 60529, IP 54.

Enclosure pattern - Surface and weatherproof.

Accessory mounting - Direct to enclosure.

Enclosure material - Impact resistant plastic.

Enclosure finish - Natural or self coloured.

Coverplate finish, all accessories to match moulded plastic, colour as shown on drawings/schedules.

Coverplate pattern - Surface type.

Ancillaries

Earthing terminal integral within switch box.
Neon indicator with red lens, illuminated in `ON' position, for connection units.
Protective shrouds to rocker bars.
Screwed weathering cap and chain for socket outlets.
Switch rocker bar colour as shown on drawings/schedules.
Operating keys for key operated switches, minimum number 2.
Fuses to BS 1362 as shown on drawings/schedules.
Conduit and cable entries
   Threaded entries to suit cable/conduit system.
Cable termination - Manufacturer's standard.

**2020A INTERIOR LIGHTING SWITCHES - GENERAL PURPOSE:**
Standard - BS 3676 Part 1, enclosure box to BS 4662.
Switch type
   Rocker bar - moulded plastic, secret key or dimmer as indicated on drawings/schedules.
Rating - 5A or 15A.
Gangs as indicated on drawings/schedules.
Switch mechanism - Snap action microgap.
Pole configurations
   Single pole, double pole, 2 way or intermediate as indicated on drawings/schedules.

**2020B INTERIOR LIGHTING SWITCHES - GRID:**
Standard - BS 3676 Part 1, enclosure box to BS 4662.
Switch type
   Rocker bar - moulded plastic or secret key as indicated on drawings/schedules.
Rating - 5A or 15A.
Switch mechanism - Snap action microgap.
Pole configurations
   Single pole, 1 way, 2 way or intermediate as indicated on drawings/schedules.

**2050A LUMINAIRE CONNECTORS - GENERAL AND EMERGENCY LIGHTING:**
Rating - 2A.
Connector type
   Fixed terminal strip, screw cover and cord grip to BS 67.
Load carrying capacity to match selected luminaire.

**2050B LUMINAIRE CONNECTORS - GENERAL LIGHTING:**
Rating - 2A.
Connector type
   3 pin plug/socket to BS 546.
Load carrying capacity to match selected luminaire.

**2050C LUMINAIRE CONNECTORS - CORD GRIP GENERAL AND EMERGENCY LIGHTING:**
Rating - 2A.
Connector type
   Cord grip type plug/socket and screw on retaining cover to BS 5733 3 pin or 4 pin.
   Luminaire supporting coupler to BS 7001 as shown on drawings/schedules.
Load carrying capacity to match selected luminaire.
2060A **LAMPHOLDERS - BC TYPE:**
Standard - BS 5042.
Lampholder type - Bayonet clip - B22.
Fixing
   - Bracket - straight or angle, or suspension as indicated on the drawings/schedules.
Finish - Manufacturer's standard.
Material - Heat resistant moulded plastic.
Ancillaries
   - Cord grip, lampshade ring or protective lampshade ring as indicated on the drawings/schedules.

2060B **LAMPHOLDERS - ES TYPE:**
Standard - BS EN 60238.
Lampholder type - Edison screw - E27.
Fixing
   - Bracket - straight or angle, or suspension as indicated on the drawings/schedules.
Finish - Manufacturer's standard.
Material - Heat resistant moulded plastic.
Ancillaries
   - Cord grip, lampshade ring or protective lampshade ring as indicated on the drawings/schedules.

2070A **ISOLATING SWITCHES - BS 3676 PART 1:**
Provide isolating switches for fixed appliances.
Utilization category as indicated on the drawings/schedules.
Making capacity as indicated on the drawings/schedules.
Standard - BS 3676 Part 1, enclosure box to BS 4662.
Switch type - Rocker bar.
Rating as indicated on the drawings/schedules.
Pole configuration
   - DP, three pole or TPN as indicated on the drawings/schedules.

2070B **ISOLATING SWITCHES - BS EN 60947-3:**
Provide isolating switches for fixed appliances.
Utilization category as indicated on the drawings/schedules.
Making capacity as indicated on the drawings/schedules.
Standard - Enclosure box to BS 4662, BS EN 60947-3.
Switch type - Rocker bar.
Rating as indicated on the drawings/schedules.
Pole configuration
   - DP, three pole or TPN as indicated on the drawings/schedules.

2090A **SOCKET-OUTLETS - SINGLE, SWITCHED:**
Standard
   - 13A socket-outlet to BS 1363, enclosure box to BS 4662.
Switching - Switched.
Switch type - Rocker bar - plastic.
Rating - 13A.
Ancillaries

**AfDB: Electrical Specifications**
Plug tops 25% of number of sockets, fused as indicated on drawings/schedules.
Gangs - 1

2090C SOCKET-OUTLETS - DOUBLE SWITCHED:
Standard
  13A socket-outlet to BS 1363, enclosure box to BS 4662.
Switching - Switched
Switch type - Rocker bar - plastic.
Rating - 13A.
Ancillaries
  Plug tops 25% of number of sockets, fused as indicated on drawings/schedules.
Gangs - 2

2130A TELEPHONE AND DATA OUTLET SOCKETS - GENERAL PURPOSE:
Standard
  For jack plug to BS 6312, enclosure box to BS 4662.
Size - Standard.
Circuit configurations as indicated on the drawings/schedules.

3010 EARTHING:
Ensure metal framework of equipment is bonded to main earth point. Ensure that cable CPC's are connected to earth bar.
Provide earth CPC between earth lug on metal box and accessory casing except where accessory is encased in plastic.

3020 PROTECTION:
Ensure there is no physical or electrical damage to accessories when they are removed from their packaging and during installation.
Provide masking covers for surface mounted accessories to protect surface from paint.
Where accessories are flush mounted install front plate after painting is finished.

3030 FIXING:
Align accessories horizontally and vertically, as indicated. Where accessories are grouped, mount horizontally in line and parallel to each other and equidistant.
Fix cover plates to boxes with brass fixing screws.

3040 MEASURING MOUNTING HEIGHTS:
Take measurement for position of electrical accessories to the centre line of equipment from either finished floor or worktop. Where specified height coincides with top of tiling, leave a clear gap of 50mm above tiling.
Mount equipment below a worktop 100mm below underside of worktop.

3050 MOUNT ELECTRICAL ACCESSORIES:
Accessory  Location  Height(mm)
Lighting switch  1000

AfDB: Electrical Specifications
## Socket outlet

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>300</td>
</tr>
<tr>
<td>Kitchen</td>
<td>1150</td>
</tr>
<tr>
<td>Above worktop</td>
<td>150</td>
</tr>
</tbody>
</table>

## Fused connection unit

<table>
<thead>
<tr>
<th>Category</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>300</td>
</tr>
<tr>
<td>Above worktop</td>
<td>150</td>
</tr>
</tbody>
</table>

## Room thermostat

- 1000

## Telephone outlet

- 300

## Push button

- 1000

## Fire alarm manual call point

- 1000

## Bell or buzzer

- 1800

In car parks and garages comply with appropriate petroleum regulation for mounting heights of socket outlets.
Y80 EARTHING AND BONDING COMPONENTS

1000 GENERAL

1010 MATERIALS GENERALLY:
Use materials and installations methods in accordance with BS 6651, BS 7671, BS 7430, Electricity Supply Regulations and Local Electricity Supply Authority Requirements as appropriate.

2000 PRODUCTS/MATERIALS

2010A CONDUCTORS FOR LIGHTNING PROTECTION SYSTEMS - HORIZONTAL AIR TERMINATIONS:
Use - Horizontal air termination or down conductor.
Minimum dimension - BS 6651 Table 4.
Form - Strip.
Material - Copper, BS 1432 C101 or C102, annealed.
Coverings
None or PVC, colour as indicated on the drawings/schedules.
Accessories
Ridge Saddle; conductor clips - non-metallic; glazing bar holdfast; slate holdfast; backplate holdfast; all accessories sized to suit conductors.

2010B CONDUCTORS FOR LIGHTNING PROTECTION SYSTEMS - SELF SUPPORTING AIR TERMINATIONS:
Use - Air termination, vertical.
Minimum dimension - BS 6651 Table 4.
Form - Rod.
Material - Copper, BS 1433 C101 or C102, hard drawn.
Coverings - None.
Accessories
Terminal base; ridge saddle; rod brackets; rod to tape coupling.

2010C CONDUCTORS FOR EARTHING SYSTEMS TO BS 7430:
Use - Earthing conductor.
Minimum dimension - BS 7430, current density $50\,\text{A/mm}^2$.
Form - Strip.
Material - Copper, BS 1432 C101 or C102, annealed.
Coverings - None.
Accessories - Conductor clips, metallic.

2020A CONDUCTOR JOINTS:
First Conductor
Form - strip; material - copper.
Dimensions
To BS 6651 table 4 minimum for lightning protection system or for conductor current density $50\,\text{A/mm}^2$ for earthing systems.
Y80 EARTHING AND BONDING COMPONENTS

Second conductor
  Form - rod; material - copper.
  Dimensions
    To BS 6651 table 4 minimum for lightning protection system or for conductor current density 50A/mm² for earthing systems.
Solid joint - Brazed or welded, thermic.
Disconnecting test joint
  Square clamp, oblong clamp, plate clamp or screw-down clamp.

2030A TAPE FIXING DEVICES:
  Secure bare copper tape to structure with fixing devices which avoid piercing tape and ensure 3mm (minimum) clearance of tape from structure, at 450mm maximum, centres.
Material for lightning protection systems
  Non-conducting.
Material for system earthing
  Naval brass to BS 2872 Grade CZ112 or gunmetal conductor to BS 1400 Grade LC2.

2040A EARTH ELECTRODES FOR LIGHTNING PROTECTION SYSTEMS:
  Standard - BS 6651.
  Form
    Rod, roll threaded, or building or structural element indicated on the drawings.
  Dimensions
    Rod Diameter - 15 mm - nominal.
    Rod Length - 2.4m (2 x 1.2) minimum.
  Earth electrode couplings
    Use silicon bronze alloy to BS 2874 Grade CS101 or aluminium bronze alloy to BS 2871 Grade CA102, counter bored to completely enclose rod threads. Ensure rods meet in centres of coupling.
    Use high strength driving cap in contact with driven rod and couplings of compatible material fully enclosing the rod threads.
  Interconnect electrodes using 25 x 3 mm bare copper tape.
  Earth electrodes in drawpits
    Provide concrete cover, permanently labelled, for electrodes installed through cable drawpit bases.
  Material, minimum size as BS 7430 Table 4
    Molecularly bonded copper clad steel rods to BS 7430 or BS 6651.
  Accessories
    Rod to tape clamp or U-bolt clamp. Accessories sized to suit earth rod and connector.

2040B EARTH ELECTRODES FOR SYSTEM EARTHING:
  Standard - BS 7430.
  Form
    Rod, female thread each end or building or structural element as indicated on the drawings.
  Dimensions
    Rod Diameter - 15 mm - nominal.
    Rod Length - 2.4m (2 x 1.2) minimum.
  Earth electrode couplings
    Use high strength driving cap in contact with driven rod and couplings of compatible material fully enclosing the rod threads.

AfDB: Electrical Specifications
Interconnect electrodes using bare copper tape 25mm x 6mm. Earth electrodes in drawpits
  Provide concrete cover, permanently labelled, for electrodes installed through cable drawpit bases.
Main earth conductor connection
  Connect main earth conductor to first electrode using heavy duty purpose made silicon aluminium bronze body conductor clamp and high tensile phosphor bronze bolt.
Material, minimum size as BS 7430 Table 4
  Copper - BS 1432 C101 or C102 or BS 2874 C101, C102 or C106, hard drawn.
Accessories
  Rod to tape clamp. Sized to suit earth rod and connector.

2060 EARTH ELECTRODE CLAMPS:
Connect tape to electrode head using heavy duty purpose made silicon aluminium bronze body connector clamps or leaded gunmetal body connector clamps, and high tensile phosphor bronze bolts to BS 2874 Grade PB102.

2070A EARTH ELECTRODE INSPECTION FACILITIES:
Provide enclosure for each connection between earth conductor and associated earth electrode system. Install so that top is flush with finished ground or floor level. Ensure enclosure provides adequate access for testing purposes. Provide pit details for builders work.
  Labelling - Wording, Earth.

2090A MAIN EQUIPOTENTIAL BONDS:
Provide main equipotential bonds in accordance with BS 7430 and BS 7671.
  Material - Insulated cable, single core to BS 6004.
Use no joints in main equipotential bonds.

2100A SUPPLEMENTARY EQUIPOTENTIAL BONDS:
Provide supplementary equipotential bonds to BS 7430 and BS 7671.
  Material - Insulated cable, single core to BS 6004.
Use no joints in supplementary equipotential bonds.

2110A CIRCUIT PROTECTIVE CONDUCTORS:
Material
  Insulated cable, single core to BS 6004 as indicated; metallic screwed conduits (excluding flexible); metallic trunking with tinned copper links; armouring and/or metallic sheathing of armoured cables or integral conductor of multi-core cable.
Size
  Provide protective conductors sized in accordance with BS 7671 (IEE Regulations) 543-01-03 and Tables 54B, 54C, 54D, 54E and 54F or provide protective conductors sized in accordance with BS 7671 (IEE Regulations) 543-01-04 and Table 54G.

2120 EARTHING CLAMPS:
Use clamps complying with BS 951, for bonding pipes and lead sheathed cables.

2130A EARTH BUSBARS:

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Material
Manufacture earth busbars from hard drawn, tinned, high conductivity copper bar.

Substation Earth busbar
75 x 13mm cross section 600mm minimum length.

Main Earth Terminal busbar
25 x 6 mm minimum for incoming live conductor not exceeding 50mm² and 50 x 6 mm minimum for incoming live conductor over 50mm².

2140 TEST LINKS:
Provide two test links, in connections between main earth conductors and earth busbar. Fabricate each from two additional sections of earth busbar; use remaining section as removable test link. Secure 12mm high tensile brass studs to fixed sections of busbar and drill corresponding clearance holes in test links and provide brass washers, nuts and locking devices to secure frame/neutral earthing and test links.

2150 LUGS/TAGS:
Provide lugs or tags to enable connection of bonding conductors to equipment earth terminals.

2160 PROTECTIVE CABLE TERMINATIONS:
For bolted connections use crimp type lugs compressed by automatic tool to achieve correct pressure and crimp depth.

2170 PROTECTIVE CONDUCTOR WARNING NOTICES/LABELS:
Provide a permanent label durably marked in letters 4.75mm minimum height "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE", in visible position, at each bonding conductor connection to extraneous conductive parts.

2180 MAIN EARTH CONDUCTOR - WARNING TAPES:
Provide green/yellow PVC tapes labelled "EARTHING CONDUCTOR" over complete external lengths of main earth conductors at 300mm depth below finished ground.

2190 EARTH BAR LABEL:
Label earth bar "SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE" with wall mounted laminated plastic tablet engraved in 10mm high red letters on white ground.

3010 CLEAN EARTH DISTRIBUTION:
Install clean earth distribution in double insulated cables from earth electrodes to equipment points. Mount all busbars with insulators and separate from other earthing systems.

3020 DISSIMILAR METALS:
Ensure, where dissimilar metals are used for system, that purpose made jointing materials are used such that corrosion and deterioration of the electrical connection are not caused. Ensure bonding connections to other metal parts of building are electrolytically compatible with those metal parts. Use the guidance given in BS 7430 Table 8 when bonding dissimilar materials.

3030A TAPE JOINTS:
Provide waterproof protection at joints subject to moisture. Joint copper tapes by brazing, using zinc-free brazing metal with melting point at least 600°C or thermic welding.

3040 STRANDED CONDUCTOR JOINTS:
Provide waterproof protection at joints subject to moisture. Joint copper stranded conductors with compression joints to BS 3288 Part 1.

3050A PROTECTIVE CABLE TERMINATIONS:
For bolted connections use crimp type lugs compressed by automatic tool to achieve correct pressure and crimp depth. Make connections between tape and equipment using high tensile grade brass bolts with brass nuts, washers and locking devices. Use phosphor bronze bolts, nuts and washers where connections are liable to corrosion.

3060A EARTH ELECTRODES:
Location
Locate electrodes not less than 2m distant from building/structure protected, and away from telecommunication and pilot cables and metallic fences.
Driving
Drive rods vertically into ground with purpose designed electric hammer. (Where impenetrable strata encountered at shallow depth, drive at 30° to horizontal).
Depth of rod
2.4m minimum below finished ground surface.
Depth of Electrode heads
Locate electrode heads just below ground level.
Spacing
Where electrodes are installed in a group ensure minimum distance between electrodes is twice depth of rods. Where rods for "clean" earth are installed ensure distance from any other system rods is six times depth of "clean" rods.
Tape Depth
Install interconnecting or electrode tape 750mm below finished ground level, rising vertically at each electrode. Connect groups of electrodes to main earth conductor via bolted link in inspection pit as BS 7430 for test purposes.
Y81 TESTING AND COMMISSIONING OF ELECTRICAL SERVICES

1000  GENERAL

1010  INSPECTION AND TEST PROCEDURE:
Comply with BS 7671 Requirements for Electrical Installations (the IEE Wiring Regulations), IEE Guidance Notes Number 3 Inspection & Testing and other British Standards as appropriate.

1020A  INCORPORATED EQUIPMENT CHARACTERISTICS:
Obtain and use information from manufacturers of equipment provided.
Use information provided, for equipment supplied by others and incorporated into installation.

1040  SUPPLY CHARACTERISTICS:
Obtain information called for in BS 7671 about supply characteristics from Supplier, other than where to be measured as part of testing procedure.

1050  DESIGN INFORMATION:
Obtain all design assumptions, calculations and any other information to enable compliance with BS 7671 to be verified.

1060A  INITIAL VERIFICATION:
Carry out detailed inspection to verify the requirements of BS 7671 Section 712 in the order given in clause 712-01-03 for New Installation or Altered or Added Installation as appropriate.

1070A  TEST EQUIPMENT AND CONSUMABLES:
Provide test equipment and consumables to complete tests satisfactorily, and to retest any failed installations following corrective measures.
Test equipment quality assurance requirements to BS EN 30012-1.

1080A  TESTING
Carry out in the same order as published the tests required by BS 7671 Section 713 for New Installation or Altered or Added Installation as appropriate.

1090A  CONTINUITY OF PROTECTIVE CONDUCTORS:
Confirm continuity. Use ac source or dc source.

1100A  EARTH FAULT LOOP IMPEDANCE (ZS):
Use 25 A test current. Measure and record source impedance (Z^S).
If alternative LV supply arrangements are available, measure Z^S when using supply with highest impedance.
Measure Z^S with main equipotential bonding conductors connected. Do not summate values of several parts of each loop.

1110  SETTINGS AND ADJUSTMENTS:
Confirm characteristics and settings of protective devices are within maximum and minimum specified tripping times.
Check correct operation of devices.
Confirm interlocks and sequences operate safely and as indicated.

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CALIBRATION:
Provide current certificates of calibration for all instruments used during test procedures. Record particular instrument identity on record sheets.

CERTIFICATION AND REPORTING
Complete and hand over to the Bank a Completion and Inspection Certificate to BS 7671 Appendix 6 for New Installation or Altered or Added Installation as appropriate.

COMPLETION CERTIFICATES:
Provide completion certificates for electrical installations in accordance with BS 7671 (IEE Regulations).

RECORDS:
Record all results and instrument readings on approved Record Sheets and hand over to the Bank two copies for each inspection and test.

WORKMANSHIP
CONDUCTIVE PARTS:
Test conductive parts simultaneously accessible with exposed conductive parts of extraneous conductive parts. Establish that they are either not an extraneous conductive part, or that they are reliably connected by metal to main equipotential bonding.

PHASE SEQUENCE:
Check and confirm correct polarity of all conductors in all circuits.

CABLES:
Test continuity and insulation of buried cables immediately after back-filling. Test continuity and insulation of buried cables prior to handover.

CABLES:
Test continuity and insulation of buried cables immediately after back-filling. Test continuity and insulation of buried cables prior to handover. Perform HV tests on buried HV cables prior to handover.

CONDUIT, TRUNKING AND DUCTING:
Test and confirm electrical continuity before installing cables.
1000  GENERAL

1010A  LABELS AND NOTICES:
Apply identification labels and notices in accordance with BS 7671 (IEE Wiring Regulations), Clause 514 to all electrical cables plant and equipment including components of mechanical systems.
Fit labels and notices as shown on the Contract drawings.

BS 7671 Labels and Notices
- Identification of protective devices.
- Diagrams, charts or tables to comply with Clause 514-09.
- Warning notices, voltages in excess of 250 volts.
- Periodic inspection and test notices.
- Residual current device notices.
- Earth electrode safety electrical connection label.
- Bonding conductor connector point to extraneous conductive parts label.
- Earth free local equipotential bonding areas warning notice.
- Electrical separation areas warning notice.
- Outdoor equipment socket outlet notice.

1020A  MATERIALS:
Use materials for labels and notices with a predicted life equal to or greater than the design life of the electrical cables, plant, equipment or installation to which it refers.

External
- Signwritten, or stencil in paint compatible with surface.
- Colour - Background, plant standard finish. Lettering, white.

Internal
- Engraved thermosetting plastic laminate.
- Colour - Background, white or red. Lettering, red or white.

1030A  FIXING - INTERNAL:
Fix labels and notices using materials compatible with label or notice and surface to which it is fixed by screws into tapped hole or bolted complete with washer nut and locking device.

1040A  ARRANGEMENT:
Obtain approval prior to manufacture, with regard to style, colour, lettering, size and position of all labels and notices.
- Provide sample showing style, colour, lettering and size, for approval.

1050A  LETTERING AND SIZE OF LABELS AND NOTICES:
Ensure that all lettering and symbols comply with the requirements laid out in BS 7671 (IEE Wiring Regulations), paragraph 514 and BS 5378. Use Table 6 of BS 5378 for height of lettering where not otherwise indicated. Ensure labels and notices of adequate size for the lettering required, and allow a minimum margin around all lettering of one line space vertically and two letter spacing horizontally.
- Font - Helvetica Medium.
- Size - BS 5378 table 6 or 5mm minimum high letters.
1060 CONDUCTOR ARRANGEMENT:
Arrange circuit polarity so that phases read in phase rotation order followed by the neutral, if any, from top to bottom in horizontal conductor layouts and left to right in vertical conductor layouts. Ensure flat horizontal arrays have leading phase to the left and neutral to the right from left to right when viewed from supply point. Arrange phase or live pole of two wire apparatus at top or left hand and neutral and earth both at bottom or right hand side. In all cases, ensure conductor arrangements defined are when viewed from front face of all equipment and terminating facilities. Apply identification markers in accordance with BS 7671 (IEE Wiring Regulations), Clause 514 to all conductor termination points.

2000 PRODUCTS/MATERIALS

2010A SAFETY SIGNS:
Label all electrical plant and equipment using safety sign A.2.8 of BS 5378, Part 1 where voltages above ELV exist.
Provide with each safety sign A.2.8 supplementary or text signs complying with BS 5378, Part 3 as indicated on drawings.
Label all electrical plant and equipment with the labels specified in the appropriate British Standards for that plant or equipment. Identify each substation and main switchroom with safety sign A.2.8 to BS 5378, Part 1 with supplementary signs to BS 5378 Part 3, notices and signs required by BS 5306 for any fire extinguishing system and notice giving details of,
- Name of the Substation or switchroom.
- The presence of Medium and Low Voltages.
- Administrative instructions for access.
- Location and method of contacting controlling authority.
- Actions to be taken in an emergency.

2020A PLANT AND EQUIPMENT LABELS:
Fit labels on all items of plant, equipment, switches, etc., include the following information:
- service controlled, circuit reference, voltage, type of supply and phase etc., circuit protection type and rating.

2030 MAINTENANCE NOTICES:
Fix notices giving warning of, and instructions on, any special maintenance procedures to plant and equipment as indicated.

2050A MOTORS AND STARTERS LABELS:
Fit identification labels to all motors, starters and starter panels. Ensure positive identification of respective motors and starters. Provide motors with non-corrodible labels attached adjacent to each bearing giving details of the lubricant to be used. Mark direction of normal rotation on motor casing. Provide labels to identify motor equipment fitted with surge suppressors and thermistors stating that insulation test voltages must not be applied to thermistors and thermistor control units. Ensure labelling is compatible with schematic and wiring diagrams, and complies with BS 4999, Part 108.

2060A ENGRAVED ACCESSORY PLATES:
Engrave switchplates, spur units, pushes and special plates for bedhead units, call systems, fire alarms, etc. Use 6mm high letters with engraving coloured red.

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2070A SWITCHGEAR:
Fit labels on switchgear as required by BS 7671 and BS EN 60439 to indicate duty of unit, its voltage, phase and current rating, protective device rating size of conductor involved, and all other necessary details.
Use an agreed serial coding system, provide at the switch a key to the coding system.

2080 DISTRIBUTION BOARDS:
On each distribution board identify every outgoing way with a renewable circuit chart in a transparent plastic envelope permanently fitted inside distribution board cover. Clearly indicate in typed script, circuit identification number, cable size, fuse or circuit breaker rating and a description of item supplied and area supplied by circuit.

2090A SCHEMATIC DIAGRAMS:
Provide a purpose made schematic diagram permanently fixed showing the connections of the equipment and plant.
Locations and materials as indicated in contract preliminaries.

2100A SPECIAL PURPOSE EARTHING:
Fit labels to special purpose earthing conductors and connection points, describing their purposes and any instructions necessary for their operation and maintenance.
IT equipment ‘Clean Earths’.
Telecommunications functional earths.

2130A CABLE IDENTIFICATION:
Provide all cables, other than final sub-circuit wiring enclosed in conduits or trunking, with labels fixed at each end of cable either side of wall and floor penetrations at approximately 12m intervals at convenient inspection points by means of non-releasable plastic straps, minimum width 4mm.
Ensure labels show the reference number of cable.

2140A TERMINAL MARKING AND CONDUCTOR IDENTIFICATION:
Provide for switchgear and control gear elements whose terminals are marked in accordance with BS 5472 (EN 50005) and BS 6272 (EN 50042). Use a unique reference to identify each element in the switchgear or control gear. Mark on or adjacent to each element its reference. Identify each terminal for connection to external wiring or cabling using a reference system complying with BS 5559 (EN 60445) based on the element reference and the appropriate element terminal reference.
Adjacent to terminals.
Use lettered or numbered ferrules or sleeves to BS 3858 to mark each auxiliary conductor or control cable core with the identity of the terminal to which it is connected and the reference of plant or equipment to which it is connected and the identity of the terminal at the remote end. Ensure that main circuit conductors are identified in accordance with BS 7671 (IEE Wiring Regulations) paragraph 514-06. Ensure that all identification of terminals and conductors is recorded and included on record drawings and in operation and maintenance documentation.

2150A UNDERGROUND CABLE IDENTIFICATION:
Identify external underground cable routes by means of approved markers along their length at
distances not exceeding 50m and where a change of direction occurs on such routes. Provide cables markers with a brass plate or impress concrete to clearly indicate the reference of group of cables or reference number of cable and operating voltage of cable.

Provide key to any reference system used at switchgear.

Mark and protect direct buried cables with plastic tape yellow printed black `DANGER ELECTRIC CABLES' elsewhere.

**2160A CABLE CONDUCTOR COLOUR CODING:**

Identify cable conductors in accordance with BS 7671 (IEE Wiring Regulations) paragraph 514, note that a lighting sub-circuit switch wire is a phase conductor in a single phase circuit.

All single phase final sub-circuit phase wiring coded Red.

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**2170 CABLE JOINTING AND TERMINATION:**

Connect all cables in the installation so that the correct sequence of phase rotation is maintained throughout. Where straight through joints are approved, joint medium voltage conductors as they lie, ensuring their complete length is phased out on completion. Ensure connections at terminations of MV cables are made in the correct phase rotation and ensure cable conductor termination marking if any, complies with this phase sequence. Where straight through joints are approved on low voltage cables, whether power cables or control or auxiliary cables, joint conductors strictly in accordance with their colour or numeric coding. Where such joints are approved on mineral insulated or other non-coded conductor cables, identify each core at the joint and make the joint core to core.

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**2180A CABLE SHEATH IDENTIFICATION - INTERNAL:**

Use to identify coloured cables sheaths for various services as follows.

- Fire, red;
- Clock circuits, brown;
- Telecommunications, grey;
- Data as system suppliers requirements;
- Control, black;
- LV, black;
- LV mineral insulated, orange;
- MV red.

Code cables for various services using alphanumeric symbols as follows.

- Code letters preceding cable reference.
  - Fire alarm, FA.
  - Clock, CL.
  - Telecommunications, T.
  - Data, D.
  - Control, C.
  - Low voltage, LV.
  - Extra low voltage, ELV.
  - LV Essential circuits E.
  - Medium voltage, HV.

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**2190A CABLE SHEATH IDENTIFICATION - EXTERNAL:**

Identify cable sheaths for various services in accordance with NJUG4, as follows.

- MV Red.
- LV Black.

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Y82 IDENTIFICATION - ELECTRICAL

Telecommunications and data, Grey.

2200A ADDITIONAL SAFETY SIGNS:
Provide at locations shown or as appropriate safety signs to BS 5378 with dimensions as Tables 5 and 6 of Part 2. Modular height (a), 75mm.

Application
For main switch and electrical plant room access doors. BS 5378 Appendix A, complete with supplementary signs as shown.
Part 1, A.1.4., A.1.3, with supplementary sign ‘Authorised persons only’.

Application
For use with permit to work systems, BS 5378 Appendix A, complete with supplementary signs as shown.
Part 3, A.1.3. Printed on rigid plastic, with hanging loop, with supplementary wording ‘Do not operate. Work in progress’.

Application
For use at each emergency stop. BS 5378 Appendix A, complete with supplementary signs as shown.
Part 3, A.4.5. With supplementary sign ‘Emergency stop push-button’.
SCHEDULE OF MANUFACTURERS
### ELECTRICAL

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SCHEDULE OF DRAWINGS

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SCHEDULE OF DRAWINGS

ELECTRICAL

DRAWINGS

LEGEND

SCHEMATICS

- H.T. Panel
- Main LV Panel
- Solar Inverter Panel
- Main Building Panel
- Sub-Main Board(SMB) – UPS Distribution
- Ground Floor Sub-Main Board
- Typical (First – Fourth) floor Sub-Main Board
- External Lighting Panel
- Telephone and Data Distribution
- Fire Detection and Alarm System
- Central TV system
- Security and Access Control System

SITE PLAN

- Services Lighting Layout
- Services Cableroute Layout
- Security Post Lighting Layout
- Security Post Power & Miscellaneous services Layout
- Security Post Fire Alarm & Detection Layout
- Plantroom Lighting Layout
- Plantroom Equipment layout and Power Layout
- Plantroom Fire Alarm & Detection Layout

MAIN OFFICE BUILDING

- Ground Floor Plan: Lighting Layout
  Power Tel, Data & TV servises
  Fire Detection & Alarm, Security, PAS sytem

- First Floor Plan: Lighting Layout
  Power Tel, Data & TV servises
  Fire Detection & Alarm, Security, PAS sytem

- Second Floor Plan: Lighting Layout
  Power Tel, Data & TV servises
  Fire Detection & Alarm, Security, PAS sytem

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SCHEDULE OF DRAWINGS

• Third Floor Plan: Lighting Layout
  Power, Tel, Data & TV services
  Fire Detection & Alarm, Security, PAS system

• Fourth Floor Plan: Lighting Layout
  Power, Tel, Data & TV services
  Fire Detection & Alarm, Security, PAS system

• Roof Floor Plan: Lightning Protection Layout

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