



SPECIFICATION

FOR THE

ELECTRICAL SERVICES INSTALLATION

AT

SLIGO UNIVERSITY HOSPITAL T2 TRANSFORMER AND SWITCHGEAR REPLACEMENT

P08 04

LINKED PRACTICES

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ELECTRICAL SERVICES SPECIFICATION

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ELECTRICAL SERVICES SPECIFICATION

PREFACE

1. DEFINITIONS:

- 1.1. The definitions ascribed to the parties and consultants to the contract in the Form of Tender shall prevail throughout this Specification.
- 1.2. 'Indicated' as used in 'as indicated', 'where indicated', 'unless otherwise indicated' and like phrases shall mean indicated in the addenda to the Specification and/or in the equipment schedules in the appendices, or on the drawings or any other relevant contract documentation. 'Specified' shall be interpreted similarly.
- 1.3. 'Approval' means approval in principle from the Engineer, and does not infer that the Contractor is in any way relieved of the consequential responsibility of adhering to the spirit of the contract documentation with regard to standard of workmanship, materials and design intent.

2. INTERPRETATION:

- 2.1. Section 1: Indicates the scope of the Contractor's responsibility to provide a complete and satisfactory working installation, complying with all necessary requirements, for hand-over to the Employer.
- 2.2. Section 2: Provides a description of the electrical services general specification for materials along with any other relevant information.
- 2.3. Section 3: The Particular Specification sets out the requirements and standards for workmanship, material, equipment and services/systems to be provided. The Contractor shall ensure that the installation conforms to the standard of workmanship called for and that materials and equipment are to the standard required.
- 2.4. Appendices: includes specifications for specialist equipment, record documentation and sub-system certification, particular to the project.
- 2.5. This Specification shall be read in conjunction with the general conditions of contract, drawings and all other contract documentation. Any discrepancy shall be referred to the Engineer in writing for clarification as soon as practicable.

SECTION 1 - GENERAL REQUIREMENTS

1. SCOPE OF MAIN CONTRACTOR'S & SPECIALIST CONTRACTOR'S RESPONSIBILITIES:

- 1.1. The Main Contractor, and where the specialist contractor acts as main contractor, shall be entirely responsible for the works set out in the contract documentation, whether under construction or during tests, and until the works have been handed over, or deemed to have been handed over in compliance with the conditions of the contract. Receiving the responsible Engineer's or Employer's Representative approval does not relieve the Main Contractor of this responsibility.
- 1.2. Unless otherwise stipulated, the works shall include the provision of electricity supply, delivery, installation, testing, commissioning, setting to work, making good any defects that occur during the defects liability period, provision of 'as-installed' drawings and maintenance and operating manuals, and all of the labour and materials necessary to form a complete installation, whether or not all the necessary (labour) components are indicated.
- 1.3. The Main Contractor shall be responsible for ensuring that any firm that is appointed on Client's instruction or otherwise, appointed by him/her/them as a specialist contractor (in this case Mechanical, Electrical & Transport Specialist Contractors) a supplier or as a supplier to the specialist complies with and fulfils all the relevant undertakings and conditions described in the contract documentation. The Main Contractor shall also be responsible for incorporating the works of his/her/their Specialist Contractors into the programme of works.
- 1.4. The Main Contractor shall conduct inspections and tests and compile reports during manufacture or fabrication on or off site, as and when required, to ensure that quality, workmanship, delivery, assembly, erection, testing, setting to work and completion by the Specialist Contractors are satisfactory.
- 1.5. The Main Contractor shall, by submitting a tender; guarantee that all materials, equipment and work carried out shall be 'Fit for the Purpose' and shall secure similar guarantees from his appointed Specialist Contractors and specialist's suppliers.
- 1.6. The design of plant, equipment, specialist installations or materials used by the Main Contractor and or Specialist's Contractors and requiring the input of the manufacturer's specialist designers shall be the responsibility of the manufacturer/supplier of the specific plant, equipment, specialist installations or materials. The Main Contractor and or Specialist's Contractors shall, when placing orders, be responsible for ensuring that all relevant information regarding every aspect of the project is passed on to the manufacturer/supplier and for ensuring that the plant, equipment, specialist installations or materials are suitable for the application and comply with the Engineer's design intent and the Specification.

- 1.7. Unless otherwise indicated, all materials and equipment to be installed shall be new. Equipment shall be installed in accordance with manufacturers' written instructions.
- 1.8. Where equipment is supplied by others as free-issue items, the Main Contractor or Specialist Contractor if so agreed, shall take delivery, erect, test and commission the equipment unless otherwise indicated.
- 1.9. The Main Contractor shall ensure before ordering that all equipment can be installed in allotted spaces and shall maintain adequate access for maintenance and repair.
- 1.10. Notice prior to cover shall be given in reasonable time by the Main Contractor to the Engineer whenever any works or materials are intended to be covered by earth, lagging, structural duct covers, walls, floors, ceilings, building in, or otherwise.
- 1.11. The Main Contractor shall ensure to include for all services expansion and flexible joints as necessary to cross building expansion joints.
- 1.12. The Main Contractor shall regard all maps, plans, drawings, sketches, etc. of the works as highly confidential, all as set out in accordance with the main contract conditions, and shall only release them to other persons on a need-to-know basis.
- 1.13. The whole of the works shall be carried out to the complete satisfaction of the Engineer and Employer's Representative who shall reserve the right to reject any workmanship and materials that, in their opinion of, do not conform to the Specification. The Main Contractor shall be obliged to carry out such alterations or replacements of materials at his own expense.
- 1.14. The Main Contractor shall not interrupt or interfere with any existing services without prior written permission from the client's representative.
- 1.15. The Main Contractor and Specialist Contractor shall note that the Engineer reserves the right to change, amend or modify the specifications, drawings, design or layout as required throughout the contract and in accordance with the contract conditions

2. STANDARDS AND CODES OF PRACTICE:

- 2.1. Unless specifically stated otherwise, or approved by the Engineer, installation, materials and equipment shall be in accordance with the relevant Irish, European and British Standards and Codes of Practice and CIBSE Guidelines, whether indicated in this Specification or not.
- 2.2. Although relevant Standards and Codes of Practice are referred to in this Specification, the Main Contractor and Specialist Contractor shall ensure that all Standards and Codes of Practice shall be current editions dated three months before the date for return of tenders.

- 2.3. Any differences between these Standards and Codes of Practice and any part of this Specification shall be brought to the attention of the Engineer for clarification.
- 2.4. Commodities conforming to Standards shall be clearly and indelibly marked with the Standard reference. Where this is impracticable, the relevant advice and delivery notes shall include the Standard reference with which they are to comply.
- 2.5. Where commodities/services are specified to be by registered/approved firms under Certification and/or Quality Assurance schemes, the proposed firm must be a current participant in the relevant scheme.
- 2.6. Certificates or compliance with Standards, Certification schemes and/or Quality Assurance schemes shall be provided to the Engineer on request.

3. NATIONAL AND LOCAL AUTHORITIES:

- 3.1. The Main Contractor and Specialist Contractor shall ensure that all materials, items of equipment, methods of installation and standards of workmanship are in compliance with the recommendations and requirements of the relevant national and local authorities and shall arrange for such authorities to witness any testing which may be required.

4. ACTS AND REGULATIONS:

- 4.1. The installation(s) shall comply with all Acts, relevant Statutory Instruments and Regulations including any special Regulations issued by the electricity, gas and/or water authorities. The tender shall be based on the Acts and Regulations current on the date for return of tenders. If these Acts and/or Regulations are amended or new Acts and/or Regulations are enacted after that date the Contractor shall inform the Engineer and Employer's Representative immediately.

5. HEALTH AND SAFETY:

- 5.1. The Main Contractor and Specialist Contractor (s) shall comply fully with the health and safety requirements as detailed in the Main Contract and all relevant Safety, Health and Welfare at Work Statutory Instruments. Of particular note are the relevant sections of the following:-
 - 5.1.1. Health and safety and welfare at work Act 2005
 - 5.1.2. S.I.299/2007 General Applications
 - 5.1.3. S.I.732/2007 General applications

5.1.4. S.I.291/2013 Construction Regulations

- 5.2. All equipment deployed in a temporary capacity (during installation works) and permanently as part of the project contract works shall comply with the current European directives in connection with safety of machinery and electrical equipment:-

5.2.1. Machinery Directive (2006/42/EC)

5.2.2. The low Voltage Directive (2014/35/EU)

5.2.3. Electro Magnetic Compatibility (2014/30/EU)

All such equipment shall carry the “CE” marking. Equipment not bearing this marking will be rejected by the Engineer and the Main / Specialist Contractor shall be required to replace it with certified (and marked) equivalents without cost penalty to the Client.

- 5.3. The hardware/software/firmware supplied shall be accompanied by documentation stating this conformity.

6. INTERIM CLAIMS:

- 6.1. Claims for interim payment shall be in accordance with the information set out in the Main Contract.
- 6.2. The specialist progress claims shall be broken down as per the form of tender.
- 6.3. Interim claims in respect of specialists’ works shall be accompanied by a certificate confirming that the works executed and materials on site under the claim are in accordance with the contract documentation. Failure to provide this certificate will invalidate the claim.

7. ASBESTOS MATERIALS:

- 7.1. Asbestos materials shall not be installed. This requirement applies to major items, e.g., thermal insulation, and to sundry minor components such as gaskets, fire seals and valve packing.
- 7.1.1. Where there is asbestos in an existing installation where works are proposed, it is subject to the Chemicals (Asbestos Articles) Regulations, 2011 (S.I. 248 of 2011). Further, where installation work could interfere with said asbestos, a full risk assessment pertaining to the implications of proposed the work, and the potential affects relating to the asbestos, is required.

- 7.2. Should asbestos (historical, natural, or new) be identified by the Contractor on the site during the course of the contract the following procedural undertakings must be adhered to.
- 7.2.1. Work is to cease in the associated area and the area is to be identified as a restricted area,
 - 7.2.2. The Main Contractor Foreman and the Engineer are to be informed immediately
 - 7.2.3. Work can only continue in the restricted area once a suitable risk assessment and method statement in line with S.I. 386/2006 and S.I. 589/2010 is undertaken and approved by all affected parties.

8. CFCS AND HCFCs:

- 8.1. Products containing and/or requiring the use of CFCs in their manufacture will not be permitted. Those containing and/or requiring the use of HCFCs may only be used with the permission of the Engineer. The Main Contractor shall confirm in writing that such products are free of CFCs and/or HCFCs prior to delivery to site.

9. SITE ADMINISTRATION:

- 9.1. The Main Contractor and Specialist Contractor(s) shall provide all necessary supervision during the execution of the works. Suitably qualified engineering staff shall be employed and given charge of the site works from commencement to completion. Supervisory staff shall be on site during the whole of the time that the work is in progress and shall be authorised to receive instructions from the Engineer on the Contractor's behalf.
- 9.2. The Main Contractor and Specialist shall allow for attendance at all site meetings involving the services installations, and for attendance at site visits by the Engineer, for the duration of the Contract.
- 9.3. The Main Contractor shall provide staff of sufficient number and competence as necessary in the opinion of the Engineer and Employer's Representative for preparing programmes, records, working drawings, builder's work drawings, progress drawings and any other documentation as is required for efficient and satisfactory execution of the works.
- 9.4. The Specialist Contractor shall provide all necessary staff as and when required to liaise with the Main Contractor in the production and maintenance of the overall works programme. Such staff shall also engage in programming and the monitoring of progress within the overall programme. The programme and required updates are to be in compliance with the Main Contract Conditions, and shall be available to the Engineer on request.

- 9.5. The Main Contractor shall submit a type written report detailing the manpower and plant on site in relation to the services installations in accordance with the terms of the main contract.

10. SPECIALIST SERVICES DRAWINGS AND CO-ORDINATION:

- 10.1. The definition of drawing types applying to the works shall be as set out in BSRIA BG 6 "A Design Framework for Building Services".
- 10.2. The tender drawings associated with this contract have been brought to the stage of *detailed design drawings* as detailed in BSRIA BG 6. These drawings show the locations of plant items and services routes in such detail as to indicate the design intent and the initial co-ordination of services (design stage) with the building structure. The drawings do not indicate the precise position of services, but it should be feasible to install the services within the general routes and general locations indicated, and to produce *co-ordinated drawings* or *installation drawings* without major re-routing of services. Symbol and line conventions are in accordance with the schedule of symbols and notations issued with the tender documents.
- 10.3. Identified ATEX classified hazardous areas are to be supplied to all contracting services. The onus is on the Main Contractor to qualify that all services entering and exiting these zones are suitable and clearly identified to all affected parties at a design stage as well as the suitable marking and identification at the completion stage.
- 10.4. The Main Contractor shall have responsibility for performing the overall co-ordination process in respect to all building services with each other and with the building elements. The Main Contractor shall assign to this task staff with proven knowledge and experience of building services to ensure that the service co-ordination activities are successfully completed. The responsibilities of the staff so assigned shall include but are not limited to: -
- 10.4.1. The realistic programming of all building services works and activities and the incorporating of this programme into the main contract programme.
- 10.4.2. The timely and adequate production, by the services specialist contractors, of drawings as described below.
- 10.4.3. The timely and adequate provision of services related samples, patterns, mock-ups and setting out details for design team comments.
- 10.4.4. The interpretation of all building services drawings and specifications and the resolution of queries raised by the building services and other specialist contractors and, if necessary, obtaining clarification or instructions from the design team.
- 10.4.5. The day to day co-ordination of site setting out of building services and sequencing of installation to ensure that systems are not damaged due to premature installation.

- 10.4.6. Being present at all meetings called to discuss building services and to report on the works and progress.
- 10.4.7. The timely and realistic programming of inspections, testing, commissioning and handover of the building services works, all in accordance with the services specification, and in sufficient detail to provide for a design team option to attend during these activities.
- 10.4.8. The timely and realistic programming of the provision of record drawings and maintenance manuals, in accordance with the services specifications.
- 10.4.9. Any further activities considered necessary by the Main Contractor in order to fulfil his obligations with regard to services co-ordination.
- 10.5. The specialist contractor associated with the mechanical installation shall undertake the role of Lead Services Co-ordinator. This specialist contractor shall take the lead, under the direction of the Main Contractor, in the services co-ordination activities. These activities and responsibilities include but are not limited to the following:-
 - 10.5.1. Before any installation work commences and in time to meet programme dates, the Lead Services Co-ordinator shall meet with representatives of all relevant parties associated with the works to examine all drawings and all aspects of the detailed services co-ordination. Co-ordination meetings shall be of sufficient number to ensure that the co-ordination of services with each other and the building structure, together with the sequencing of installation, is successfully carried out.
 - 10.5.2. From information agreed at the co-ordination meetings, the Lead Services Co-ordinator shall develop and produce co-ordination drawings. The co-ordination drawings shall be of sufficient detail to demonstrate that all services can be installed with adequate space for access, commissioning, and ongoing maintenance. Access points for commissioning and maintenance shall be, as far as is practicable, grouped to minimise the number of points required and located in areas where they will cause the least disruption to the functioning of the building when in use.
 - 10.5.3. When the Lead Services Co-ordinator completes the co-ordination drawings and agrees the proposals with all relevant parties, the co-ordination drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Lead Services Co-ordinator shall revise the proposals until agreement is reached with all parties.
- 10.6. The specialist contractors shall co-operate fully with the Main Contractor to ensure that the services co-ordination activity is successfully completed.
- 10.7. Based on the final agreed co-ordination drawings, the Specialist Contractor shall develop and produce installation drawings for the works included in his contract. The installation drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Specialist Contractor shall revise these drawings until agreed by all parties.

- 10.8. When the installation drawings are agreed and completed, the Specialist Contractor shall develop and produce *builder's work drawings (installation stage definition)* for the services included in his contract. The builder's work drawings shall be forwarded to the Main Contractor for comment and then issued to the design team for comment. If necessary, the Specialist Contractor shall revise these drawings until agreed by all parties.

11. BUILDERS' WORK:

- 11.1. All builders' work such as the cutting of holes/chases in masonry/concrete walls and floors, the provision of foundations for plant and equipment, etc., will be carried out by the Main Contractor. The Specialist Contractor shall, however, be responsible for providing all information required by the Main Contractor for the correct marking-off and setting out of such work.
- 11.2. Where services pass from one fire compartment to the next, the integrity of the fire barrier shall be maintained. Unless otherwise indicated, the Main Contractor shall carry out such making good of fire compartments. The Specialist Contractor shall be responsible for ensuring that no damage is caused to services.
- 11.3. The Specialist Contractor shall include for all services expansion and flexible joints as necessary to cross building expansion joints.
- 11.4. Where applicable, details of walls and ceilings having a wet plaster finish shall be as listed in the Architect's schedules. Services in these areas shall be installed insofar as possible to alleviate the need for access. Where access is necessary, the Specialist Contractor shall be responsible for the correct indication and marking out of such access.

12. PAINTING:

- 12.1. Ferrous sheet materials shall receive a protective coating of paint at works after suitable preparation, or be treated with the manufacturer's approved corrosion-resisting metal finishing process. Any deterioration or damage to the manufacturer's protective coating during storage, installation and before hand-over shall be made good by the Specialist Contractor to the satisfaction of the Engineer.
- 12.2. The surfaces of all ferrous metalwork including pipework, hangers, supports, etc. which are not protected by galvanising, works-applied primer, or protective paint shall be suitably prepared and painted with one coat of zinc phosphate primer. All such surfaces, with the exception of pipework that is to be insulated, shall be finished with two coats of approved quality non-metallic paint to BS 5493. Where surfaces will be subjected to temperatures above 100°C, the finishing coat(s) shall be heat-resisting paint, and the primer normally omitted. The Contractor shall ensure that:-

- 12.2.1. Surfaces are cleaned in accordance with BS 7079 before they are painted.
- 12.2.2. Those parts of the installation required to be left unpainted (e.g. brasswork) are so left.
- 12.2.3. Where required services are correctly identified to ensure the use of approved paint of the correct colour to comply with BS 1710.
- 12.2.4. Exposed threads on steel conduit (running couplers) are to be treated in accordance with manufacturers guidelines.

13. MOCK-UPS, DEMONSTRATIONS AND SAMPLES:

- 13.1. The Specialist Contractor shall allow for the provision of mock-ups, samples and functional and operational demonstrations of all systems.
- 13.2. The Specialist Contractor shall submit samples of proposed materials to the Engineer for written approval as and when required.
- 13.3. All items that require a factory acceptance test are to be approved by the Engineer prior to transportation to the site.

14. RATIONALISATION OF SUPPLIES:

- 14.1. Items, fittings and accessories to be used in quantity shall, where practicable, be the product of one manufacturer and shall be used only for the purpose recommended by that manufacturer.

15. COMMISSIONING AND TESTING

- 15.1. The Main Contractor shall notify the Engineer in writing when, in their opinion, the services installation works or parts thereof are ready for testing and commissioning. The specialist contractor shall then carry out the tests. The specialist contractor shall prove to their satisfaction that all test results are in accordance with the specification and where relevant national requirements. The specialist contractor shall then functionally test all installations in the presence of the Engineer and shall make all specified tests to the satisfaction of the Engineer.
- 15.2. Should the specialist's contractor's initial tests fail to demonstrate that the plant and equipment are properly installed and functioning correctly, the cause of the failure shall be investigated and adjustments as may be necessary made. The commissioning and functional demonstrations shall then be repeated to the satisfaction of the Engineer.
- 15.3. Where it is not possible at the particular time of commissioning and testing for full load conditions to be obtained or simulated, the specialist contractor shall repeat such operations of full load or simulation thereof at a time when this can be achieved.
- 15.4. Where portions of the work are commissioned and tested separately, the Specialist Contractor shall, upon Practical Completion or Completion of Section as defined in the Main Contract Conditions, demonstrate to the Engineer that all the several portions are capable of proper simultaneous operation.
- 15.5. In cases where the construction programme is such that the Specialist Contractor will need to return to the portion of the building taken over and occupied by the client in order to undertake testing, balancing, adjustment, etc., the Specialist Contractor shall take all necessary precautions against, and shall be responsible for, any damage caused whilst working in such areas for that purpose.
- 15.6. Subsequent to the completion of all testing and commissioning to the satisfaction of the Engineer, the specialist contractor shall operate the plant and shall demonstrate that the overall systems function correctly in accordance with the requirements of the Specification. A period of at least seven days full running and operation shall be considered reasonable for this demonstration. During this period the specialist contractor shall be responsible for the operation and maintenance.

16. PRACTICAL COMPLETION

- 16.1. Practical Completion of the specialist's contractor's works, or agreed phase or part of the works, shall not be effected until the specialist contractor has fulfilled their obligations under the Main Contract conditions and in particular demonstrated to the satisfaction of the Engineer that the following aspects are complete:-
- 16.1.1. All works to be complete other than minor snags or defects which could be reasonably completed within an agreed programme without causing disruption to the client's or their Agent's use of the Building or agreed part thereof. In respect of this clause, specifically but not uniquely, the employer's representative shall be the sole arbiter of what may be considered minor, reasonably completed, an agreed programme and disruption to the Employer.
 - 16.1.2. All tests and functional demonstration have been undertaken successfully
 - 16.1.3. All final copies of the Record Drawings, Schedules, Operating and Maintenance manuals and test certificates have been supplied in a format agreed to the Engineer.
 - 16.1.4. All spares, keys, tools, oils, chemicals and other materials required by the specification for the running and maintenance of the Engineering Systems as specified are to have been supplied.
 - 16.1.5. All instruction of the client's staff to have been satisfactorily completed in accordance with the programme for handovers agreed with the employer's representative.

17. TRAINING OF CLIENT'S PERSONNEL

- 17.1. Provide experienced personnel to instruct the Employer's personnel in the operation, maintenance and servicing of all of the installations. Give instructions for an appropriate period commensurate with the scale and complexity of the installations and not less than three working days before the Specialist Works are handed over.

18. SYSTEMS USED BEFORE PRACTICAL COMPLETION

- 18.1. Systems may not, without the prior written approval of the consultant engineer be used before Practical Completion.
- 18.2. Systems to be used before practical completion for the benefit of the Main Contractor and / Specialist Contractor must have all defective consumable elements (including lamps and tubes) replaced by new elements not more than seven days prior to Practical Completion.

- 18.3. No system shall be put into use prior to handover to the client, except for testing and commissioning, unless in accordance with the following procedure:
- 18.4. Following the receipt of written instructions, the Specialist Contractor shall operate designated parts of the Works, provided that such operation is practicable and does not prejudice the Specialist Contractor's responsibilities and obligations.
- 18.5. Allow the defects liability period to commence on handover.

19. OPERATION OF SYSTEMS BEFORE THE PRODUCTION OF RECORD DRAWINGS AND/OR OPERATING AND MAINTENANCE MANUALS

- 19.1. The Contractor is required to provide attendance, at no expense to the Client, and to put into service, operate 24 hours a day and maintain the systems to the client'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 Engineer, otherwise qualify for Practical Completion.
- 19.2. In the event of the Specialist Contractor failing to provide this service satisfactorily the Employer shall be entitled to make his own arrangements and recover the full cost through the Contract.

20. OBLIGATIONS AFTER PRACTICAL COMPLETION

- 20.1. Between the issue of a Certificate of Practical Completion and the Certificate of Making Good Defects relating to the whole or part of the Specialist Works, provide the following:
 - 20.1.1. A prompt call-back service, available at all reasonable times, to attend to any faults.
 - 20.1.2. Carry out a final test at the end of the Defects Liability Period to demonstrate to the Engineer that the Specialist Works are operating efficiently and that all components are functioning correctly.
- 20.2. Carry out all work using competent, trained personnel and except where made necessary by abuse, misuse or negligence by other than the Specialist Contractor, make no charge to the Employer.
- 20.3. Notwithstanding the foregoing paragraph, charge to the Employer the net cost of replacement of life-expired disposable parts.

21. REQUESTS FOR DEVIATION FROM SPECIFICATION:

- 21.1. Any deviation from the Specification sought by the Specialist Contractor made through the Main Contractor must be in the form of a written request and must be sanctioned in writing by the Engineer and Employer's Representative to be valid.

22. BUILDING CONTROL (AMENDMENT) REGULATIONS 2014

- 22.1. The Contractor shall include for the full implementation of the Building Control Regulations 1997 - 2014 and the Building Control (Amendment) Regulations S.I. No.9 of 2014 & S.I. No. 105 of 2014. The Contractor shall include for their attendance as required to implement the inspection plan prepared by the design team and the ongoing inspections.
- 22.2. The Contractor shall notify the design team when their works are ready for inspection, during the proposed program of works. The Contractor is advised to contact the Main Contractor to establish the proposed programme of works.
- 22.3. The Contractor shall give adequate notice for the ongoing inspection prior to the completion of any individual element of the Mechanical, Electrical and Lift Installations and shall confirm that the works are in compliance with the Building Regulations and will be complete for inspection. Any defects of workmanship, materials, performance, design of equipment, maladjustments or other irregularities which become apparent during the inspections shall be rectified at the Contractor's expense.
- 22.4. The Contractor shall ensure that sufficient time is allowed in the Main Contractor's programme for each of the ongoing inspections. Throughout the execution of the works, the Contractor shall be responsible for ensuring compliance with all relevant Contract Drawings & Specifications, Building Regulations, Safety Codes and Local Authority requirements and shall notify the Engineer of any infringement which directly or indirectly detracts from the safe and satisfactory operation of the installation whether or not such infringement relates to the works covered in this Specification or to the associated works of others.
- 22.5. The Contractor shall provide all necessary Certificates of Compliance with regard to the requirements of the Building Regulations, the Building Control Regulations 1997 - 2014 and the Building Control (Amendment) Regulations S.I. No.9 of 2014 & S.I. No. 105 of 2014 and as requested by the Engineer.
- 22.6. In addition to and accompanying the Commencement Notice, there are two statutory assignments and three statutory certificates to be completed on-line using the Building Control Management System (BCMS), on-line system. The format for these are as per the Second Schedule, S.I. 9 2014.
- 22.7. At completion, a fourth statutory certificate is completed on-line using the Building Control Management System (BCMS) on-line system. The format for these are as per the Second Schedule, S.I. 9 2014.

- 22.8. The Preliminary Inspection Plan is a statutory document prepared by the Assigned Certifier that to be submitted to the Building Control Authority by the Employer with the Commencement Notice a minimum of two weeks and a maximum of four weeks in advance of the commencement of the works. At project completion the Inspection Plan as implemented is submitted to the Building Control Authority.
- 22.9. It is the responsibility of the Main Contractor to employ competent persons to supervise the works. The Inspection Plan shall not in any way diminish the duty of the Main Contractor to properly supervise, and any defective works, whether identified during or after the contract period, remain the sole responsibility of the Main Contractor.
- 22.10. The Main Contractor shall include with his tender submission a Method Statement and his own Preliminary Inspection Plan indicating his own inspection and supervision regime.
- 22.11. A copy of the Preliminary Inspection Plan will be included in the Architectural tender documents. The inspection requirements set out in this document do not in any way relieve, replace, or reduce the Main Contractor's duty to supervise the works.
- 22.12. COORDINATION OF TESTS, INSPECTIONS & RECORDS:
- 22.12.1. The Main Contractor shall meet and coordinate and update the Inspection Notification Framework and Preliminary Inspection Plan with the proposed construction programme and shall incorporate the agreed inspection milestones.
- 22.12.2. All elements identified in the Inspection Notification Framework are to be made available for inspection at each milestone:
- Complete,
 - Not concealed
 - Safely accessible.
- 22.12.3. The Main Contractor shall facilitate random inspections by the Assigned Certifier and / or Ancillary Certifiers as if such inspections were identified in the Inspection Notification Framework.
- 22.12.4. The Main Contractor shall provide in a timely manner all CE certificates, Declarations of Performance and test certificates for materials, products and assemblies.
- 22.13. ADVANCE NOTICE AND TIME FOR INSPECTIONS:
- 22.13.1. Due consideration shall be given by the Main Contractor for inspection notices. No claims for extension of time or financial claims shall be considered for delays arising out of inspection or re-inspection requirements.

- 22.13.2. The Main Contractor shall ensure advance notifications are issued with respect to works to be inspected that are identified in the Inspection Schedule. The minimum advance notice required for inspection of items of works is five working days.

22.14. RE-INSPECTIONS/FOLLOW UP INSPECTIONS:

- 22.14.1. The minimum notice required for re-inspection of items of works not complete or requiring remedial works shall be three working days.
- 22.14.2. The Assigned Certifier shall without delay notify the Main Contractor through the Contracting Authority / Employers Representative of any incomplete work at a given milestone identified in the Inspection Notification Framework.
- 22.14.3. The Main Contractor shall diligently ensure that any incomplete areas items at given milestones are completed and that such works are kept available for inspection again, or until a record of completion is furnished, as may be required by the Assigned Certifier.
- 22.14.4. The Main Contractor shall diligently ensure that any areas of non-compliance are rectified and that such works are kept available for inspection again, or until a record of rectification is furnished, as may be required by the Assigned Certifier.
- 22.14.5. The Main Contractor shall ensure all tests and certificates for materials, components and assemblies listed in the Inspection Notification Framework are undertaken in a timely way. Any test failure shall immediately be made known to the Employers Representative / Assigned Certifier; the materials/works in question shall be replaced / rectified and retested undertaken prior to proceeding with subsequent work.
- 22.14.6. It is the responsibility of the Main Contractor to coordinate and supervise the works and no claim for delay or cost shall arise from the requirement to re-inspect.

22.15. CONTRACTOR'S PROGRESS RECORDS:

- 22.15.1. The Main Contractor shall maintain progress records and inspection records prepared by him in accordance with the Method Statement submitted at tender and as set out in this document.
- 22.15.2. Contractors shall include in their tender costs for the provision of progress records as the works proceed.

22.16. METHOD OF RECORDING:

- 22.16.1. Promptly provide a copy to the Assigned and Ancillary Certifier of all progress records and inspection records prepared by the Main Contractor and the sub-contractors.

- 22.16.2. At completion stage, the Main Contractor shall issue the Ancillary Certifier a copy of the records prepared by the Main Contractor and the sub-contractors.
 - 22.16.3. The Main Contractor shall also retain in his own central office all records prepared by them and the sub-contractors for a minimum period of six years.
 - 22.16.4. One hardcopy and softcopy of all records shall be issued five days in advance of the nominated completion date.
 - 22.16.5. The record should include evidence of the successful execution of the Main Contractor's method statement on supervision including tests, check sheets, photographs and memos. All evidence shall be indexed by location and date.
 - 22.16.6. Acceptance of such records shall not constitute approval or imply that their content has been examined.
- 22.17. Main Contractors shall submit the following documentation as part of their tender. Failure to do so may invalidate the tender:
- 22.17.1. Main Contractor's Competence Assessment
 - 22.17.2. Sub-Contractor/Specialist Competence (Ancillary Certifiers) Assessment
 - 22.17.3. Main Contractors Method Statement
- 22.18. Tenderers shall note that Practical Completion for this contract is contingent upon the successful registration of the works on the Building Control Management System.
- 22.19. Tenderers shall note that this project shall require a Prior Notification of Completion to be submitted to the Building Control Authority in advance of completion.
- 22.20. The Main Contractor shall provide four to six weeks in advance of the nominated completion date all completed and/or 'prospective' documentation and confirmations for Registration. The Assigned Certifier and the Main Contractor shall co-sign the Completion Certificate.
- 22.21. The Assigned Certifier and Main Contractor shall then lodge/upload the documentation onto the Building Control Authority system.
- 22.22. Notwithstanding any statutory duty to retain same, in advance of project completion, the Main Contractor shall issue to the Assigned Certifier a copy of all inspection records retained by the Main Contractor during the course of the Project.

23. CONSTRUCTION PRODUCTS REGULATIONS:

- 23.1. Building Regulations Technical Guidance Document Part D (TGD D) provides guidance in relation to Part D of the Second Schedule to the Building Regulations. It relates to materials and workmanship as inserted by the Building Regulations Part D Amendment 2013 (S.I. No. 224 of 2013). To ensure the quality of materials used in construction, Building Regulations Technical Guidance Document Part D requires compliance with the EU Construction Products Regulation (Regulation (EU) No. 305/2011).

- 23.2. The EU Construction Products Regulation lays down harmonised conditions for the marketing of construction products and is directly applicable in Irish law. From July 1st 2013 CE markings have been mandatory for all construction products placed on the market in the European Economic area which are covered by a Harmonised European Standard (hENs). Although other forms of certification (IAB, BBA Certs etc.) may be available for a given product or material, if a Harmonised Standard is in place then the product/material must be CE Marked and have an associated Declaration of Performance.

- 23.3. The EU Construction Products Regulations, (CPR), sets rules for placing construction products on the EU market. All Construction products placed on this market, which includes both Ireland and Northern Ireland, must comply with the CPR, irrespective of where they are manufactured. This means they must be CE marked, use harmonised standards, (hENs), to demonstrate conformity, be certified by an EU-27 notified body and have an up-to-date EU Declaration of Performance, (DoP). Reference to a BS EN on a Declaration of Performance or CE Marking is not compliant with the relevant EU Regulations.

- 23.4. To affix the CE marking to a construction product, the manufacturer is obliged to draw up a Declaration of Performance (DoP) when a construction product is covered by a harmonized standard or conforms to a European Technical Assessment. Any information about the product's performance in relation to the essential characteristics may be provided only in the form of a declaration of performance. The CE marking shall be applied to the product itself and where this should not be possible to the packaging or accompanying documents.

- 23.5. Only manufacturers or importers can place products on the market, whereas distributors, importers and manufacturers can make them available thereafter. An importer or distributor may be considered to act as a manufacturer and is thus subject to all obligations for manufacturers in cases where he places a product on the market under his name or trademark or modifies a construction product already placed on the market. Even though not expressly stated in the CPR, the DoP and all accompanying documents are considered legal documents and shall not be altered but supplied as they have been provided by the manufacturer.

- 23.6. To this end, the Contractor shall, when selecting and submitting products and equipment for use in construction works, review the manufacturer's Declaration of Performance to ensure it is suitable for their intended use and in addition shall review National Annexes and/or Standard Recommendations for guidance on appropriate minimum performance levels for specific intended uses of the proposed equipment/product.

24. ENVIRONMENTAL PRODUCT DECLARATIONS:

- 24.1. As part of the procurement and equipment submittal process the Contractor shall endeavour to select products from manufacturers who have verified environmental life cycle impacts to encourage the use of products and materials for which life-cycle information is available and that have environmentally, economically, and socially preferable life-cycle impacts.
- 24.2. Life-cycle assessment and environmental product declarations:
 - 24.2.1. Products with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the “cradle to gate”.
 - 24.2.2. Product-specific Type III EPD -- Internally Reviewed. Products with an internally critically reviewed LCA in accordance with ISO 14071. Products with product specific internal EPDs which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
 - 24.2.3. Industry-wide Type III EPD -- Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator. Products with industry-wide EPDs, which conform to EN 15804 or ISO 21930, and registered and published within EPD programmes which need to meet the requirements of International Standard ISO 14025 and at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the “cradle to gate”.
- 24.3. Environmental Product Declarations which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
- 24.4. Product-specific Type III EPD -- Products with third-party certification (Type III), including external verification and external critical review and at a minimum cover product stage (A1-A3) showing the impacts of manufacture and the supply chain from the “cradle to gate”.

SECTION 2 - GENERAL SPECIFICATION (6-)

1. EQUIPMENT SAFETY:

- 1.1. The Contractor shall be responsible for the safety of all electrical equipment including that supplied by others for installation under the electrical contract.

2. FIRE COMPARTMENTS:

- 2.1. The building is divided into fire compartments as indicated on the Architect's drawings. Where services pass from one compartment to the next, the integrity of the fire barrier must be maintained. The Contractor shall install fire barriers inside trunking and busbar systems which pass through such fire compartments (section 527, I.S. 10101). The Contractor shall be responsible for ensuring that such activities do not cause any damage to services installed.

3. POSITIONS OF EQUIPMENT AND OUTLETS:

- 3.1. The positions of equipment and outlets shown on the Engineer's drawings, unless otherwise stated, are for tendering purposes only. The exact positions shall be agreed with the Engineer and Architect.
- 3.2. The Contractor shall make a careful study of the Architect's detailed drawings and furniture layouts before commencing to mark out for work in any room. Any obstruction to the proper positioning of the outlets shall be resolved by the Contractor with the services co-ordinator to the satisfaction of the Engineer.
- 3.3. Where outlets for switches, sockets, etc., are specified to be installed in tiled walls or other regularly patterned surface, care shall be taken to ensure that the outlet boxes are positioned to the satisfaction of the Architect at no extra cost to the contract. Similar care shall be taken where luminaires are installed on finished ceilings.
- 3.4. Note that due to the nature of this building, the Contractor shall include for any item of equipment or outlet shown in a room to be positioned anywhere within that room i.e., positions will not be fixed until the furniture layout is determined.

4. WET PLASTER FINISH:

- 4.1. Walls and ceiling having wet plaster finish will be as detailed in the Architect's schedules which are available to the Contractor. Services installed in these areas shall be installed to alleviate the need for access.

5. LOCATIONS FOR SURFACE INSTALLATION:

- 5.1. Surface installations shall be provided where wall finishes are bare-faced blockwork painted or attic or plant spaces - for details see Architect's schedules.

6. LOCATIONS FOR CONCEALED WORK:

- 6.1. In all other locations apart from those adverted to in the preceding clause, the installation shall be carried out as a concealed system with conduits recessed in the walls and in the spaces above the false ceilings.

7. CONDUITS IN PATENT METAL STUD PARTITIONS:

- 7.1. Patent metal stud partitions may be used in sections of the building and because of their bearing on the installation of electrical services it is extremely important that the Contractor make himself fully familiar with the details and locations of these partitions (before submitting a tender) which may be indicated on the Architect's floor plans and detail drawings.
- 7.1.1. Wiring systems within metal stud partitions shall be in accordance with clauses 522.8.14 and 52.8.14.1 of I.S. 10101.
- 7.2. Runs of conduit shall be installed in accordance with the partition manufacturers specification and the Contractor shall be deemed to be aware of all relevant details.
- 7.3. Conduits shall enter only at the top of the partition, the metal ceiling channel of the partition being cut. Notching should not be permitted unless carried out by the person responsible for installing the stud work. The preferred conduit installation method is a set down from the true ceiling.
- 7.4. Grounds shall be provided and fixed in the partitions by the Main Contractor to which the conduit and the outlet box shall be securely fixed, the box having first been aligned and levelled. The Contractor shall be responsible for marking out the position of the conduit drops and the outlet boxes.
- 7.5. In order that the soundproofing qualities of the partitions shall not be impaired by the indiscriminate cutting of holes in them, all conduits shall be kept as close as possible to the soffit of ceiling slab and shall be so arranged as to require the minimum of interference to the plasterboard linings.
- 7.6. It shall not be permissible for conduits to enter or to pass through the partitions other than close up to the soffit of the concrete slab.

8. METHODS OF FIXING:

- 8.1. All lightweight fixings to blockwork or concrete shall be made with steel wood screws, lightly greased, and approved inserts. In damp or exposed situations, lightly greased brass screws shall be used with approved non-deteriorating plugs.
- 8.2. For lightweight fixings to ceiling tiles, plasterboards, etc., which are inaccessible to the back, approved gravity toggles or spring fixings or equivalent shall be employed.
- 8.3. All heavyweight fixings to brick or concrete shall be by means of mild steel bolts of appropriate size, or by chemical fixings, or by expanding bolt fixings.
- 8.4. Generally the size of bolts or screws shall be the largest permitted by the diameter of the hole in the apparatus to be fixed, and shall be of adequate length. When fixing any item of equipment, all bolt or screw holes provided therein shall be used and the fixing in each hole shall be secure.
- 8.5. The Contractor shall ensure that the type of fixing selected is suitable for the material being secured and for the full weight of the equipment being mounted, e.g. filled tray, luminaire complete with lamps and control gear.
- 8.6. Prior to erection on site all purpose-made mild steel brackets and rods which are not protected by galvanising shall be suitably treated to prevent rust forming and one finishing coat of grey enamel or other colour to meet the Architect's requirements at no extra cost to the contract.

9. REMOVAL OF ORIGINAL SERVICES:

- 9.1. The Contractor shall include for the making safe and careful removal of all designated redundant existing electrical services and equipment within the building.
- 9.2. Material recovered in this manner shall be presented to the Employer's representative to obtain a direction as to its disposal or retention.

10. CIRCUIT IDENTIFICATION:

- 10.1. In accordance with section 514 of I.S. 10101 labels or other suitable means of identification to identify the purpose of switchgear and control gear.

The Contractor shall include for supplying and installing permanent circuit identification tags or labels at each location where circuits are terminated i.e. socket outlets, switches, isolators, fused outlets, luminaire outlets. The positioning of the labels shall be agreed with the Engineer. The identification code shall relate to the records on the circuit charts at the switchboard or distribution board serving the circuit.

11. MATERIALS OF STEEL AND CAST IRON:

- 11.1. Conduit shall be heavy gauge welded steel hot dipped galvanised to comply with the requirements of clause 521.6 of I.S. 10101 and the I.S. EN 61386 series.
- 11.2. Conduit having an outside diameter less than 20mm shall not be used.
- 11.2.1. As per clause 521.6 of I.S. 10101, the capacity of a conduit or trunking system shall not exceed the values permitted by Annex 52A of I.S. 10101. Annex 52F of I.S. 10101 provides guidance on the selection of conduit systems.
- 11.3. As per clause 530.5.1 of I.S. 10101, equipment shall be erected according to the manufacturer's instructions in such a way that connections between wiring an equipment shall not subject to undue stress or strain resulting from the foreseen use of the equipment.
- 11.4. Conduit boxes shall be hot dipped galvanised steel and shall comply with EN 10346 series.
- 11.5. Spacer bar saddles, couplings, locknuts etc., shall be hot dipped galvanised steel and shall comply with EN 10346 series.
- 11.6. Inspection tees and elbows shall not be permitted.
- 11.7. Conduit boxes mounted outside a building shall have external fixing lugs. Boxes shall be of malleable cast iron with machine faces and brass screws for cover fixings.
- 11.8. Boxes for light switches, sockets etc., shall comply with the EN 10346 series. They shall be malleable cast iron, pressed steel, folded steel or formed steel with continuously welded sides.
- 11.9. They shall have galvanised or other approved rust inhibiting finish' and comply with the EN 10346 series.

- 11.10. In certain circumstances, boxes with formed knockouts may be permitted in flush and surface installations. Perforated knockouts shall not be acceptable in surface installations. Samples shall be provided to the Engineer for approval.

12. PVC CONTAINMENT:

- 12.1. All rigid PVC conduit shall be high impact quality to the latest IS EN 61386.
- 12.1.1. Conduit having an outside diameter less than 20 mm shall not be used. Neither shall oval conduit be used.
- 12.1.2. Conduit boxes shall meet the current IS EN 61386 and shall have brass inserts for fixing screws. Conduit boxes which support light fittings shall have the brass inserts riveted to external metal fixing lugs.
- 12.1.3. Inspection tees and elbows shall not be permitted unless through prior written agreement with the responsible Engineer.
- 12.2. All PVC trunking - surface, dado and skirting - shall be of heavy duty, high impact PVC-U material to IS EN 50085.
- 12.2.1. Trunkings may be of 1, 2 or 3 compartment type with fixed or demountable partitions.
- 12.2.2. Only components and accessories manufactured specifically for the particular trunking system shall be used.

13. FLEXIBLE CONDUIT:

- 13.1. As per clause 521.9.4 of I.S. 10101, flexible conduit systems may be used to protect flexible insulated conductors.
- 13.2. Flexible metal and PVC conduits shall be used, by approval by the responsible Engineer, where connections are made to equipment or machinery subject to vibration.
- 13.3. Pliable three-layer Class 4 conduit to EN50086 Parts 1 & 2 may be used to serve island equipment via floor chases and to serve partition systems.
- 13.4. An internal insulated earth wire shall be provided in all instances where flexible conduit is used.
- 13.5. Flexible conduit shall not be excessive in length and shall be supported with saddles where appropriate.

14. INSTALLATION OF CONDUIT AND ACCESSORIES:

- 14.1. Surface conduit shall be installed in a neat manner with suitable supports in compliance with the manufacturer's instructions.
- 14.2. Recessed conduit shall be supported with galvanised crampets and be adequately covered with cement or plaster.
- 14.3. Vertical runs shall be supported at 1.5m intervals.
- 14.4. Horizontal runs shall be supported at 1.2 m intervals.
- 14.5. Saddles shall be installed within 0.5 m of a change in direction of conduit, or proximity of termination box.
- 14.6. Draw-in boxes shall be provided at no more than 10 m intervals on straight runs and between two right hand bends or three dog-leg sets.
- 14.7. Exposed threads of steel conduit shall be painted with aluminium based paint.
- 14.8. Conduit entries shall be protected against ingress of moisture or debris during installation.
- 14.9. In exposed or wet situations conduit connections and terminations shall be water tight.
- 14.10. Conduit runs shall be approved before installation work commences and shall be at least 150 mm clear of piping and ducting of other services.
- 14.11. Conduit and adaptable boxes shall be fixed with round head brass or steel sheradised or cadmium plated screws.

15. CONDUCTORS IN CONDUIT AND TRUNKING:

- 15.1. Only insulated cables shall be installed in conduit and trunking.
- 15.2. Cabling for different services shall be installed in separate conduits.
- 15.3. Fire alarm circuits shall not share the same compartment in trunking as other services. The same applies to circuits fed from central battery systems for emergency lighting and any other emergency service circuits, unless they are wired in MICC. This will only be allowed with written approval from the Engineer.

- 15.3.1. As per clauses 528.1 of I.S. 10101, band I and band II circuits shall not be contained in the same wiring system unless the specification prescribed in the clause are facilitated.
- 15.4. As per clause 526.3.1 of I.S. 10101, cables shall not be jointed in trunking. Cables of different circuits in trunking shall be taped or bound at intervals of 3 meters for easy identification.
- 15.5. Cables exceeding 10 sq. mm shall not be installed in trunking with smaller PVC cables.
- 15.6. MICC or SWA cables shall not be installed in trunking with PVC cables.
- 15.7. Cables shall not be packed or forced into trunking in such a manner as to damage or disfigure the insulation.
- 15.8. As part of the services co-ordination process and prior to installation, the Contractor shall advise the Engineer of trunkings which will exceed their capacity (including preserving spare capacity recommended in I.S. 10101).

16. CABLES AND FLEXIBLE CORDS:

16.1. GENERAL:

- 16.1.1. Only cables and flexible cords in accordance with section 521 of I.S. 10101 may be installed. They shall be in accordance with the latest Irish Standards and shall carry the Irish Mark of Electrical Conformity (IMEC).
- 16.1.2. In accordance with section 527 of I.S. 10101, all cables are required to have a minimum rating of class DCA, S2, D2, A2, where *D* refers to resistance to fire (*A-F*, with *A* being the most resistant, and *F* being the least) and *CA* in this context stands for Cable. *S* identifies Smoke, *D* identifies Droplets, and *A* identifies the level of resistance to Acid.
- 16.1.3. Where the appropriate Irish Standard is not yet available, cables and flexible cords complying with the latest British, VDE or CENELEC standard shall be installed.

16.2. DCA APPROVED 70 DEGREES THERMAL PLASTIC CABLES AND FINAL CIRCUITS:

- 16.2.1. These shall be high conductivity stranded copper conductors with 450/750 volt grade insulation.
- 16.2.2. Colour coding of cables shall comply with the Table 51ZC.1 of Annex 51Zc within I.S. 10101 or as already established in an existing installation.

16.2.3. Unless indicated otherwise the undernoted minimum sized cables shall be used in final sub circuits.

Lighting (1 kW max. load)	-	2.5 sq. mm PVCI
Socket outlets (4 No. max)	-	4.0 sq. mm PVCI
Cooker (Domestic type) circuit	-	16.0 sq. mm PVCI
Water heater circuit (3 kW)	-	4.0 sq. mm PVCI
Water boiler circuit (5 kW)	-	10.0 sq. mm PVCI
Boilerhouse final circuit (3 kW)	-	2.5 sq. mm PVCI

16.3. FLAT TWIN AND EARTH CABLES (DCA s2d2a2 alternative to PVC):

16.3.1. These shall be as PVC cables.

16.3.2. They shall not be installed on tray, ladder or basket.

16.3.3. Mechanical protection shall be provided when necessary.

16.3.4. They shall be clipped/fixed in position according to the manufacturer's instructions.

16.3.5. They shall not be installed externally without additional mechanical protection.

16.3.6. These cables shall not be buried directly in the ground or plaster, or concrete.

16.4. NHXMH CABLES:

16.4.1. NHXMH Cables may be installed on tray, ladder and basket.

16.4.2. Mechanical protection shall be provided when necessary.

16.4.3. They shall be clipped/fixed in position according with the manufacturer's instructions.

16.4.4. When installed externally on a wall these cables shall be provided with additional mechanical protection.

16.4.5. These cables shall not be buried directly in the ground or plaster, or concrete.

16.5. PVC/SWA/LSF CABLES:

16.5.1. These are acceptable in outside and underground locations but when used within building a DCA s2d2a2 alternative is required.

16.5.2. PVC/SWA/LSF cables shall be 600/1000 volt grade and have high conductivity stranded copper conductors. They shall comply with the latest CENELEC standard.

- 16.5.3. Terminations shall be made off with approved glands and earth bonding washers. Black PVC shrouds shall be installed on glands.
- 16.5.4. Cables installed below 300 mm shall be protected against mechanical damage by a galvanised steel piping sleeve.
- 16.5.5. Where single cables are installed, they shall be supported with approved saddles or cleats. The saddles shall prevent the cable from sagging. Fixing screws shall be sheradised or cadmium plated.
- 16.5.6. Where three or more cables are installed they shall be fixed to cable tray.
- 16.5.7. See Appendix 'Underground Cable Installation' for installation methods for cables buried in the ground.
- 16.5.8. Cables installed under made ground - roads, foot-paths etc., shall be installed in high impact ducts suitably sized to facilitate withdrawal of the cables.
- 16.6. XLPE/SWA/DCA APPROVED 70 DEGREES THERMOPLASTIC CABLES:
 - 16.6.1. The same specification applies to XLPE/SWA/DCA approved 70 degrees thermoplastic cables as apply to PVC/SWA/ approved 70 degrees thermoplastic cables.
- 16.7. MINERAL INSULATED CABLES (MICC):
 - 16.7.1. Materials:
 - 16.7.1.1. Cables shall comply with I.S. EN 60702-1 and I.S. EN 60702-2 and for employment in the context of fire resistance, the cable shall comply with I.S. EN 50200 and I.S. EN 60332-1-2.
 - 16.7.1.2. Cables shall be 600 volt class except when specified cables exceed this range then 1000 volt cables shall be used.
 - 16.7.1.3. Generally, cables shall have DCA approved 70 degrees thermoplastic outer coverings when:
 - 16.7.1.3.1. They are fixed to a surface subject to dampness.
 - 16.7.1.3.2. They are fixed to a galvanised metal such as cable tray.
 - 16.7.1.3.3. They are buried direct in the ground.
 - 16.7.1.4. Terminations shall comply with the requirements of I.S. EN 60702.
 - 16.7.1.5. The classification of pots and seals shall be suitable for the application. Where DCA approved 70 degrees thermoplastic coated cable is used glands shall be fitted with DCA approved 70 degrees thermoplastic shrouds. Before positioning the shroud the gland shall be wrapped with PVC adhesive tape.

16.7.1.6. Saddles and P clips shall be of approved manufacture and shall be brass with suitable DCA approved 70 degrees thermoplastic coating if required.

16.7.1.7. Saddles and P clips shall be fixed with round head brass screws. When fixed to cable tray round head metric brass screws (M4) and nuts (M4) shall be used.

16.7.1.8. Only new, dry and uncontaminated plastic compound shall be used in sealing pots.

16.7.2. Installation of MICC Cables:

16.7.2.1. Installation of MICC cables shall be in accordance with Annex 52B of I.S. 10101.

16.7.2.2. Special care will be needed to ensure that these cables are neatly installed and terminations are properly made.

16.7.2.3. All cable routes shall be determined by the Contractor and agreed by the Engineer before work is started.

16.7.2.4. Cables shall be run at least 150 mm clear of piping and ducting of other services.

16.7.2.5. When more than three cables are installed side by side they shall be installed on cable tray.

16.7.2.6. A loop shall be introduced in a cable run immediately before its entry into equipment subject to vibration. A space shall be maintained at the point in the loop where the overlap occurs.

16.7.2.7. Bends in cables shall be formed only by standard tools approved by the cable manufacturer. Corrugation of the copper sheath will not be permitted.

16.7.2.8. Where these cables are installed in the ground they shall be protected by galvanised conduit or PVC high impact piping.

16.7.2.9. Where they are installed below 300 mm they shall be protected with galvanised steel piping fitted with a female brass bushing.

16.8. **ENHANCED CABLE:**

16.8.1. Enhanced cable shall be PH 120 type tested to I.S. EN 50200 including Annex E2. Cable supports and/or Fasteners shall be non-combustible and shall be such that the circuit integrity afforded by the cable is maintained. To this end enhanced cables may be installed as follows:

16.8.1.1. On tray or basket where the anchors/fixings are of a non-combustible construction and the cables are dressed with steel cable ties that have a 2-hour fire resistance.

16.8.1.2. Within a broken galvanised steel conduit system where the saddles are fixed with non-combustible screws or bolts that have a 2-hour fire resistance.

16.8.1.3. Direct clipping to the structure with proprietary clips to meet the PH120 integrity of the cable.

17. LOAD BALANCING:

17.1. The Contractor shall include for the testing of the completed electrical services installations to ascertain and record the loading of each circuit and of each distribution board, switchboard and control panel and to modify the circuit arrangements to ensure the loads are balanced to the satisfaction of the Engineer.

18. LABELS:

18.1. The Contractor shall include for the supply and installation of permanent labels for all terminations, switchboards, distribution panels, isolators, connection boxes and link boxes and where specified elsewhere. Samples of the labels and method of fixing proposed shall be provided for the Engineer's approval.

18.1.1. Labels shall be in accordance with section 514 of I.S. 10101.

18.2. Labels shall be traffolyte engraved black lettering on white background or red background. The labels shall be fixed by means of or superglue directly to the surface of the device so as not to compromise its use. Alternatively, the label can be permanently screwed to the local mounting material directly beside the device.

19. NOTICES:

19.1. The Contractor shall include for the supply and installation of all statutory notices (safety and information types) as required.

20. ACCESSORIES:

20.1. Accessories shall be flush, or surface mounted to suit particular requirements.

20.1.1. General requirements for electrical accessories are provided in BS 5733.

20.2. Ferrous parts shall be adequately rust-protected.

20.3. Accessories mounted outside a building shall be weatherproof and boxes shall have external fixing lugs.

- 20.4. Cable ties shall be selected to conform with the type of cable being served, the weight of the cable(s), the environmental conditions, fire rating and cable manufacturers requirements.

21. TESTING AND COMMISSIONING:

21.1. GENERAL:

- 21.1.1. The Contractor shall include for fully testing and setting to work all the installations, systems and equipment included within the contract and shall demonstrate the correct and specified performance of all such items in the presence of and to the satisfaction of the Engineer and Employer's Commissioning Officer prior to practical completion as set out elsewhere in this Specification.
- 21.1.2. It will be necessary when setting up the programme to arrange for parts of the Installations to be complete and enable other sub-contractors or suppliers to carry out their testing and setting to work.
- 21.1.3. The Contractor shall ensure that sufficient time is allowed in the Main Contractor's programme(s) to carry out the testing, pre-commissioning, commissioning and handing over of the installation. The testing and setting to work set out here shall apply to all elements of the works described in this Specification and shown on the drawings.

21.2. TESTING AND SETTING TO WORK:

- 21.2.1. On completion of works or parts of the works the Contractor shall test the various installations for polarity, earthing, insulation and protection as laid down in Chapter 6 of I.S. 10101, National Rules for Electrical Installations and any other requirements called up in the Specification.
- 21.2.2. Protective devices and ring-circuit continuity shall also be tested in accordance with the National Rules (I.S. 10101).
- 21.2.3. The various sections may not all be carried out together and the Contractor shall include for testing in stages to suit the progress of the building.
- 21.2.4. Where nominated suppliers appointments includes for testing, the Contractor shall be responsible for ensuring that all tests are properly carried out.
- 21.2.5. Test certificates shall be made available to the Contractor to enable him to record the details of the tests and upon completion of the tests systems or parts of the systems a copy shall be submitted to the Engineers.
- 21.2.6. The Contractor shall serve at least seven days' notice on the responsible Engineer before carrying out the tests, to allow the Engineer or his representative to witness the tests if he so wishes.

21.3. PRE-COMMISSIONING:

- 21.3.1. During the course of the works the Contractor shall carry out on an on-going basis the pre-commissioning of the works and shall assemble all necessary handover material which will be required at hand-over.
- 21.3.2. The pre-commissioning shall be sufficiently thorough and systematic so as to identify together with normal site inspections any obvious installation deficiencies, design errors or omissions.
- 21.3.3. The Contractor shall be responsible for the rectification of the defective work. Any problems which result from design or omissions shall be referred to the Engineer.

21.4. COMMISSIONING:

- 21.4.1. Within the time allowed in the Main Contractor's programme(s) the Contractor shall carry out the commissioning procedures.
- 21.4.2. The Contractor shall provide all instruments and equipment required to carry out the commissioning. Instruments and equipment shall be of good quality and shall be approved by the responsible Engineer.
- 21.4.3. Where necessary the Contractor shall arrange for nominated suppliers or their representatives to be present at the commissioning.
- 21.4.4. The commissioning procedures shall be thoroughly and systematically carried out by the Contractor.
- 21.4.5. The commissioning shall be carried out at a time agreed between the Contractor, the Engineer and the Main Contractor.

22. EQUIPMENT AND APPLIANCES:

- 22.1. All equipment and appliances to be supplied under the electrical services contract shall be connected in accordance with the manufacturer's instructions.

23. DESCRIPTION OF THE WORKS:

- 23.1. The following general description is intended to give an overall view of the works and does not relieve the tenderer in any way from taking account of all parts of the tender documentation.

23.1.1. Heavy plant items lifting / crantage.

23.1.1.1. Crane lift from The Mall to MV & LV Switchrooms. (2 floors over street level). 1 No. Transformer @ 5150kg), 1 No. MV Switch @ 1000kg and 1 No. LV Distribution Board - 3 No. sections @ 1200kg

Prior to the crane lift operation being carried out, the Contractors selected crantage specialist will be required to carry out a CBR test to establish the subgrade strength to ensure the ground is strong enough to support the crane's outriggers or temporary piling mats.

Provisional discussions with a crane lift specialist confirm the suitability of The Mall location for the proposed crane lift. Final weights of selected condenser units to be communicated by the Contractor to the Crane Lift Specialist.

Crane lift to take place at weekend early morning at a time of reduced pedestrian and vehicular traffic.

All lifting operations involving lifting equipment must be properly planned by a Competent Person; appropriately supervised; and carried out in a safe manner with the following non-exhaustive list of information to be provided to PSCS.

Operation 1: CBR Test

- Mobile crane to act as test weight
- CBR Test Report
- RAMS/Insurances
- Permits/Traffic Management

Operation 2: Crane Lift

- Lift Plan
- Crane Rigging RAMS
- Method Statement
- Risk Assessment
- Rigging Drawings
- Crane Position Drawings
- Traffic Management
- DCC Permits
- Contract Lift Insurances

23.1.2. Heavy plant items moving & final positioning.

23.1.2.1. MV & LV Switchrooms. 1 No. Transformer @ 5150kg), 1 No. MV Switch @ 1000kg and 1 No. LV Distribution Board - 3 No. sections @ 1200kg.

The movement / locating of any of the identified equipment shall only be undertaken by way of specialist lifting equipment appropriately rated for the designated loads and by operatives specifically trained in the lifting / moving of heavy loads.

As the LV Distribution Board will be installed on a raised floor the appropriate temporary flooring, rated for the loads noted, shall be installed in the LV Switchroom to facilitate the installation of the Distribution Board.

23.1.3. Electrical supply and distribution.

23.1.3.1. New Transformer 1.6MVA T2 to be provided.

23.1.3.2. New MV Switch MV2 to be provided

23.1.3.3. New distribution board OLB1 to be provided

23.1.4. General Services and Small Power.

23.1.4.1. OLB1 Room to be fitted out with general services and small power as noted on the drawings.

23.1.5. Lighting Services.

23.1.5.1. OLB1 & T2 Room to be fitted out with lighting services as noted on the drawings.

23.1.6. Fire Alarm System.

23.1.6.1. OLB1 & T2 Room to be fitted out with fire detection and alarm services as noted on the drawings.

23.1.7. Emergency Lighting System.

23.1.7.1. OLB1 & T2 Room to be fitted out with emergency lighting services as noted on the drawings.

23.1.8. Electromechanical Installations.

23.1.8.1. OLB1 Room to be fitted out with air conditioning services as noted on the drawings.

23.2. Note that the tender documentation includes both the Specification and the Drawings scheduled.

23.3. Phasing

Phase	Description	Works	
1	Strip out existing electrical services.	1. The drawing shall be read in conjunction with all other drawings and contract documents. 2. The electrical contractor shall be responsible for co-ordination of the electrical services for the building in conjunction with the main contractor's and mechanical contractor's installation. 3. The electrical contractor shall ensure that the installation complies with local authority codes and all other relevant standards. 4. The electrical contractor will be required to ensure services are kept live and operational within the client occupied areas at all times. To this end the contractor shall include for sufficiently sized secondary power sources/generators to all boards for changeovers as they occur. These works shall only take place once a project specific method statement and a permit to work has been submitted and approved by the engineer and the er. 5. The contractors should visit the site during the tender period to familiarise themselves with the services and thereby allow in their tenders for all temporary works necessary to keep the building operational during the construction. 6. The contractor shall include for stripping out all redundant electrical services as part of the works. 7. The contractor shall note that all works associated with the modifications and stripout of the existing electrical services shall only take place once a project specific method statement and a permit to work has been submitted and approved by the engineer and the er. 8. All existing services to be disconnected & reinstated as appropriate during construction. 9. To facilitate the refurbishment of the lv switchroom the electrical contractor shall include for but shall not be limited to the following works; Fire alarm. Survey existing fire detection and alarm installation. Detection and alarm devices to be removed. Reconfigure existing detection and sounder loops to facilitate the removal of all devices within the lv switch room. All devices removed from the fire detection and alarm system shall be programmed off the existing fire detection and alarm system. Distribution. Survey existing distribution services. Isolate and disconnect power supply to site temps db. All final circuits, wiring accessories and lights to be removed.	RAMS required Permit to works required

		Isolate and remove remaining electrical and electro-mechanical services within the lv switchroom.	
1A	Builders works & fire stopping to the new LV Switchroom & Transformer plinth.	To structural engineers detail.	RAMS required Permit to works required
1B	Install lighting services, fire detection and alarm services and general services to the new T2 Room & LV Switchroom.	As detailed on the electrical services drawing.	RAMS required Permit to works required
2	New LV Switchboard OLB1 and Transformer to be put into location.	Ol b1 installed New t2 installed New earthing arrangements installed for the lv & mv installations. Lv cabling between new T2 and OLB 1 installed tested and commissioned	RAMS required Permit to works required
3	Installation of temporary generators.	1. Install new 2 no trailer mounted, containerised, diesel generator sets, within weatherproof, acoustic enclosures of a minimum rating of 1,250kva/1,000kw each. 2. Switchgear and controls for each generator capable of synchronising one with the other and sharing load or operating on a duty/standby basis with automatic starting of the standby set in the event of a failure of the duty set. 3. Flexible, temporary cables of sufficient size to carry 1,200a on a continuous basis. 4. Separate fuel storage for each set of sufficient capacity to run its associated generator for 12 hours on full rated load. 5. Continuous 24/7 attendance on site by a technical representative of the rental generator provider. 6. Arrangements for regular fuel oil deliveries throughout the duration of the shutdown. 7. The contractor shall be required to arrange for a load test of each generator set to be carried out and certified prior to the delivery of the sets to site.	RAMS required Permit to works required

3A & 3B	Replace existing MV2	1. Existing generator to be put off-line. Lock & tag off. 2. Existing generator control to be put off line. 3. Tie supply cabling from the temporary generators into the spare ACB. 4. Main ACB to be put off line. Lock & tag off. 5. Temporary generators to be brought on-line to supply MDB2. 6. De-energize mv supply to existing MV2 RMU from MV1. Lock & tag off. 7. Disconnect mv supply from existing MV2 rmu. 8. Disconnect supply to existing transformer T2 from existing MV2 RMU. 9. Remove existing MV2 RMU. 10. Install, connect, test and commission the new MV2 rmu. 11. Re-connect existing transformer T2 from new MV2 rmu. 12. Transfer existing transformer T2 protection wiring on existing ref610 protection relay to new MV2 RMU. 13. Test and commission all transformer T2 protection functions. 14. Restore existing transformer T2 to service. 15. Temporary generators to be set off-line. 16. Re-energize supply to MDB2 from the existing transformer T2. 17. Existing generator to be brought back on-line. Full functionality of the generator to be proven. 18. Temporary generators to be disconnected following agreement with the HSE and the engineer.	RAMS required Permit to works required
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4A	Connect new T2 to MV Supply.	1. The contractor shall be required to supply, install and connect a new protection relay, covering the second transformer feeder on new MV2 RMU to protect the new transformer T2. This shall be an abb ref610, installed in a wall mounted enclosure similar to that existing protection relay installation presently covering existing transformer T2. The contractor shall also complete all connections between protection cts within the new MV2 RMU, the new T2 on board protection devices and the existing battery tripping unit. 2. Install, connect, test and commission the MV cabling from new T2 to the new MV2 RMU. 3. Install, connect, test and commission the the new T2. 4. T2 left on soak	RAMS required Permit to works required
4B	Changeover LV Supply from existing T2 to New T2.	1. Existing generator to be put off-line. Lock & tag off. 2. Existing generator control to be put off line. 3. Tie supply cabling from the temporary generators into the spare ACB. 4. Main ACB to be put off line. Lock & tag off. 5. Temporary generators to be brought on-line to supply MDB2. 6. De-energize supply to MDB2 from the existing transformer T2. 7. Isolate and disconnect supply to existing transformer T2 from new MV2 RMU. 8. Disconnect and remove lv cables from existing T2 to MDB2. 9. Install and connect new lv cables from OLB1 to existing MDB2. 10. Test and commission new OLB1 to MDB2 connection. 11. Temporary generators to be set off-line. 12. Energize supply to MDB2 from OLB1. 17. Existing generator to be brought back on-line. Full functionality of the generator to be proven. 18. Temporary generators to be disconnected following agreement with the HSE and the engineer.	RAMS required Permit to works required

23.4. Strip-out Works.

The Contractor shall include for the stripping out of all existing electrical services which become redundant by virtue of the Contract Works. The extent of stripping out shall be deemed to include all containment, accessories, fixings, mounting brackets, plant, equipment and the like.

The contractor shall note that there are services traversing the room from the areas noted for strip out. The contractor shall carry out a full survey of the electrical services installation in the works areas prior to the disconnection and removal of any cabling, containment or plant.

The contractor shall ensure that any and all live services to SUH, not within the works area, remain uninterrupted for the duration of the works. Any services found to be supplying SUH from within the works areas shall be identified and rerouted outside of the works/demolition area.

The contractor shall allow for the existing electrical services not being retained to be isolated, decommissioned and disposed of. The contractor shall allow for the disposal costs and provide certification as proof that the waste was disposed of correctly.

Where services are buried directly into elements of the building fabric which are to be retained and the removal thereof would result in excessive damage to the building fabric and finishes the said services shall be neatly cut back into the wall or floor slab so as to allow for the making good of the finishes.

When stripping out the redundant services the Contractor shall ensure that no unnecessary damage is caused to either the equipment and/or the building fabric which is to be retained.

Prior to removing redundant materials from the site the Contractor shall advise the Employer accordingly and allow them the opportunity to retain any items should they wish to do so.

The electrical contractor shall note that all works associated with the modifications/upgrades and strip-out of the existing electrical services shall only take place once a project specific method statement has been submitted and approved by the HSE and Engineer. Any shutdown's can only be for a minimal period of time and must be agreed in advance with the HSE and Engineer. All works outside the refurbishment areas must be completed out of hours with agreement with the HSE and Engineer.

All electrical installations will be in accordance with the provisions of the Safety, Health and Welfare a Work Act.

23.4.1. To facilitate the refurbishment of the T2 Room & the LV Switchroom the electrical contractor shall include for but shall not be limited to the following works;

Fire Alarm.

Survey existing fire detection and alarm installation.

Detection and alarm devices to be removed. reconfigure existing detection and sounder loops to facilitate the removal of all devices within the lv switch room.

All devices removed from the fire detection and alarm system shall be programmed off the existing fire detection and alarm system.

Distribution.

Survey existing distribution services.

Isolate and disconnect power supply to site temps db.

All final circuits, wiring accessories and lights to be removed.

Isolate and remove remaining electrical and electro-mechanical services within the lv switchroom.

SECTION 3 - PARTICULAR SPECIFICATION

PART 3.1 - ELECTRICITY CENTRE & MAIN DISTRIBUTION SYSTEM (61)

1. ELECTRICITY SUPPLY:

- 1.1. At present SUH has a 10,000 volt supply taken from the local area ESB network. The existing electrical energy centre incorporates a Primary Medium Voltage Client Switch located in the clients MV switchroom,



- 1.2. The MV Switch connects to TX1 & MV2/TX2. Refer to the existing services drawing for further detail.

- 1.3. MV2 is a Safering, Ring Main Unit by ABB and is to be replaced.
- 1.4. TX2 is a 1000kVA cast resin Transformer and is to be replaced.
- 1.5. The existing main distribution board associated with TX2 is MDB2. This is located in the LV Switchroom. The Main Incommer is a 55kA, 1600A ACB by ABB.
- 1.6. It is proposed to locate the new MV Switch in place of the existing.
- 1.7. It is proposed to reconfigure an existing room to house the new transformer.
- 1.8. The new Transformer will supply a new Off Loading Distribution Board which will in turn supply MDB2
- 1.9. The Contractor shall be entirely responsible for the works set out in the contract documentation, whether under construction or during tests, until the works have been taken over, or deemed to have been taken over under the conditions of the contract. Obtaining the Engineer's approval does not relieve the Contractor of this responsibility.

2. METERING:

- 2.1. Metering shall be in accordance with the ESB requirements for an MV supply. For tendering purposes it shall be assumed that the ESB will carry out all work relative to the consumer's MV meter. It is assumed that the existing MV metering within MV Switchroom will be retained.
- 2.2. The Electrical contractor will be responsible for coordination and liaising with ESNB in relation to installation as part of the overall programme of works.
- 2.3. The contractor shall include for all metering for the BMS system & OPW Metering system.

3. MV SWITCHGEAR:

- 3.1. The contractor shall be responsible for the supply and installation of the Medium Voltage switchgear. Refer to appendix 10 and drawings for further details.

4. MV TRANSFORMERS :

- 4.1. The contractor shall be responsible for the supply and installation of the transformers. Refer to appendix 10 and drawings for further details.

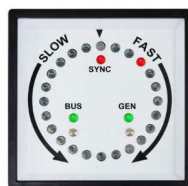
5. LV SWITCHGEAR :

- 5.1. The contractor shall supply and install a new off loading switchboard. The main switchboard and all other switchboards shall be manufactured in accordance with the Engineer's schematic drawings, the switchgear specification, Appendix 3, 9, 12, & 13 and the approved specialist supplier's drawings.
- 5.2. They shall be inspected by the Contractor and the Engineer at the specialist supplier's works before delivery to site.
 - 5.2.1. Where necessary to suit site access, board locations and safe handling the boards shall be constructed and delivered to site in sections suitable for the safe installation within the space. (The electrical contractor and switchgear manufacturer shall complete installation and delivery works using all necessary safety and specialist equipment to complete same; in this regard it is expected that a specialist company shall complete same under the electrical contract.)
 - 5.2.2. A survey by the electrical contractor, switchgear manufacturer and specialist moving company shall be completed prior to putting the new board into manufacturer and once manufactured another survey shall be completed by the electrical contractor, switchgear manufacturer and specialist moving company to analyse any and all risks with the switchgear installation and to determine the number of sections and specialists equipment necessary to complete the installation safely.
 - 5.2.3. All weights of switchgear shall be known in advance of delivery to site and shall form part of the LV Switchgear submittal with schematics.
 - 5.2.4. Switchgear sections shall be delivered and installed on site with all withdrawable breakers removed to reduce the weight of the boards and reduce risk during installation.

- 5.1. Refer to **Appendix 9** for the proposed control philosophy. The switchgear manufacturer shall incorporate the requirements of the proposed control philosophy into the switchgear systems.
- 5.2. The LV switchgear shall be manufactured in accordance with ESNB regulations for G10. The switchgear manufacturer shall incorporate G10 requirements within the main switchgear and shall liaise with the generator supplier in relation to interface requirement and incorporate within the main switchboard.
- 5.3. All Busbars must be front accessible to allow thermal imaging to take place.
 - 5.3.1. The new off loading switchboard, shall incorporate viewing ports at the busbar sections to allow Thermographic survey to take place.
 - 5.3.2. They shall be positioned every 1.5 meters along the main vertical and horizontal busbar runs.



- 5.1. The main switchboard shall incorporate Check synch relay and meter system on both sides of the coupler and the coupler.



- 5.2. All fixtures and connections shall be tightened on site before final inspection. All units shall be securely fixed before any cables are connected.
- 5.3. The main incoming ACB'S and Generator ACB'S within the off loading switchboard shall be motorised to enable automatic operation of the generator as part of the proposed control philosophy (Appendix 9).

- 5.4. The main switchboards and switchboards shall incorporate interlocking as shown on drawings and within Appendix 9.
- 5.5. The MV switchgear and LV switchgear protective devices shall only be from the one manufacturer. The use of more than one manufacturer shall not be permitted.
- 5.6. The contractor shall include for a complete MV/LV discrimination study to be carried out as part of the contract.
 - 5.6.1. The discrimination study shall be based on the final manufacturer's protective devices.
 - 5.6.2. The survey shall be carried out using the manufacturer's discrimination software from the ESB input point on the MV side through to the final outgoing circuits on the LV side.
 - 5.6.3. ESB will make available their setting at the client interface point to the hospital.
 - 5.6.4. The discrimination study should grade both the MV and LV network based on these values.
 - 5.6.5. A report shall be submitted to the Engineers clearly identifying the discrimination study exercise and the settings for all protective devices on the MV & LV network.
 - 5.6.6. Once all values have been agreed with the Engineers, the contractor shall arrange for all settings to be programmed into the MV/LV networks protective devices.
 - 5.6.7. The contractor shall include within their tender for the complete discrimination exercise to be carried out as above by a suitable specialist as part of the contract.
- 5.7. Before being commissioned all units shall be cleaned and damaged paintwork repaired and identification labels fixed.
- 5.8. The electrical contractor shall arrange for digital meters to be incorporated into the off loading switchboard integrated back to the hospital BMS system and the OPW metering system. Refer to appendix 13.
 - 5.8.1. The meter type shall be a Crompton Integra 1222 panel mounted meter



- 5.8.2. All meters shall be wired back to the hospital BMS system via a new BMS outstations to be installed within the new LV switchroom and both plantrooms. All meters shall be wired in daisy chain format (no more than 10 number per circuit) back to a set of terminals within the switchboard in accordance with the manufacturer's recommendations. All meters shall be wired to the BMS outstation.
- 5.8.3. All meters shall be wired back to the OPW system via the OPW "Resource Craft" Panel located in the new LV switchroom and plantrooms. All meters shall be wired in daisy chain format (no more than 8 number per circuit and as per manufacturers recommendations) back to a set of terminals within the switchboard. From this location, the cables shall be wired to the OPW "Resource Craft" panel.
- 5.8.4. Refer to **Appendix 13** for further details.
- 5.9. Air Circuit Breakers (ACB's):
 - 5.9.1. Air Circuit Breakers shall incorporate LSI protection (Long term, short term, & instantaneous). All ACB's shall incorporate an external 24 volt DC supply to independently power the electronic trip unit.
 - 5.9.2. All ACB's shall be capable of integrated onto a SCADA system. They shall be capable of providing real time monitoring via "Intelligent Electronic Devices" (IED's) to provide IED Parameterization (configuration/Parameter upload from IED & Change of individual parameters or parameters sets). The IED's shall come complete as part of the ACB's been provided as part of the contract.
 - 5.9.3. Refer to drawings for ACB's that are withdrawable & non withdrawable.
 - 5.9.4. All ACB's shall be rated to the perspective symmetrical short circuit value as shown on the drawings. Switchgear manufacturer shall take peak short circuit rating into consideration.
 - 5.9.5. The contractor shall provide 2 No. trolley as part of the contract for the removal and replacement of ACBs. IT shall be positioned within the new LV switchroom.
- 5.10. Moulded Case Circuit Breakers (MCCB's):
 - 5.10.1. All MCCB's shall be adjustable incorporating micrologic electronic trip units with a minimum thermal setting of 0.4 times the MCCB rating.
 - 5.10.2. All MCCBs shall be rated to the perspective symmetrical short circuit value as shown on the drawings. Switchgear manufacturer shall take peak short circuit rating into consideration.
 - 5.10.3. All MCCB's shall be fully integrated into the SCADA system to provide real time monitoring via "Intelligent Electronic Devices" (IED's) to provide IED Parameterization (configuration/Parameter upload from IED & Change of individual parameters or parameters sets). The IED's shall come complete as part of the MCB's been provided as part of the contract. Refer to appendix 7 for further details on the SCADA system.

- 5.11. The contractor shall include for individual surge protection on the main transformer incomer. It shall be type 1 and type 2 combined Lightning and surge protection complete with remote indication as manufactured by DEHN.
- 5.12. Non ferrous gland plates shall be used where single core cables are utilised.
- 5.13. As part of the tender return, the supplier shall submit a fully dimensioned elevation and plan drawing of the main switchboard layout.
- 5.14. The Contractor shall include for on-site work by the specialist supplier of the switchgear, mounting and assembly of the modular compartments, modifications to switchgear terminals, gland plates, etc. to accommodate specified cable sizes. This attendance shall also include for on-site testing of the performance of the board.
- 5.15. Main Switchboard Structural Support System:
 - 5.15.1. The floor of the new LV room shall not incorporate a continuous trench. A steel grated floor is installed within the main LV switchroom approximately 1,000mm above the trench floor level. (This grated floor is only capable of supporting persons within the room but NOT equipment). This is to facilitate the new LV cables entering and leaving the room from the new main switchboard. It is also to facilitate future maintenance etc.
 - 5.15.2. The main switchboard will therefore need to be positioned on a purpose built switchboard steel support system along its entire length that will be approximately 1,000 mm above the floor of the main LV switchroom and finish flush with the grated floor.
 - 5.15.3. The contractor shall arrange for a chartered structural engineering practice as part of the contract to design and certify a suitable structural steel support system to run along the entire length of the switchboard.
 - 5.15.4. The chartered structural engineer shall review the design of the new main switchboard with the contractor's switchgear manufacturer to ensure the correct weights, dimensions, cable entry/exit points, heights etc are agreed to ensure the support system does not in any way impact on the operation of the new main switchboard.
 - 5.15.5. The structural steel support system shall be suitably secured to the floor of the switchroom.
 - 5.15.6. The contractor shall arrange for the structural steel support system to be manufactured, certified and installed in accordance with the structural engineer's design.
 - 5.15.7. The entire structural support system shall be galvanised.
 - 5.15.8. The entire system shall be earthed in accordance with IS 10101:2020 standards.
 - 5.15.9. The contractor shall include for the design, manufacture, supply, installation, certification of the entire structural support system as part of the contract.
- 5.16. The supply of cable end boxes, interconnections, fuses and traffolyte designation labels is deemed to be included as part of the respective switchboards.

- 5.17. All switchboards and LV control panels shall have a **rubber mat** fitted to the front of the panels. The mat shall be 12mm thick (approx.), 0.9m wide and extending to the full length of the board/panel front (and rear if necessary). The mat shall conform to DIN53481 and be as supplied by Technical Equipment Company, or equal and approved. The contractor shall include for the supply and installation of the rubber mats in front of the following new switchboards:
- 5.17.1. MV switchgear
 - 5.17.2. OLB1
- 5.18. An A3 “picture frame” schematic drawing of the proposed Medium Voltage and Low Voltage systems shall be installed on the wall in the following rooms by the contractor:
- 5.18.1. MV1 switchroom.
 - 5.18.2. MV2 switchroom.
 - 5.18.3. MDB2 switchroom.
 - 5.18.4. MDB1 switchroom
 - 5.18.5. OLB1 switchroom
- 5.19. The new off loading switc board OLB1, shall incorporate clear labelling system on the front panels mimicking the busbar/ACBS/MCCB/terminals arrangement within the switchboards. The labelling shall be 20mm wide, black in colour and run continuously along the entire front elevation of the switchboard following the general arrangement of the internal busbar, ACBS, MCCB's and terminals. The continuous labelling system shall be glued onto the front panels using a suitable adhesive.



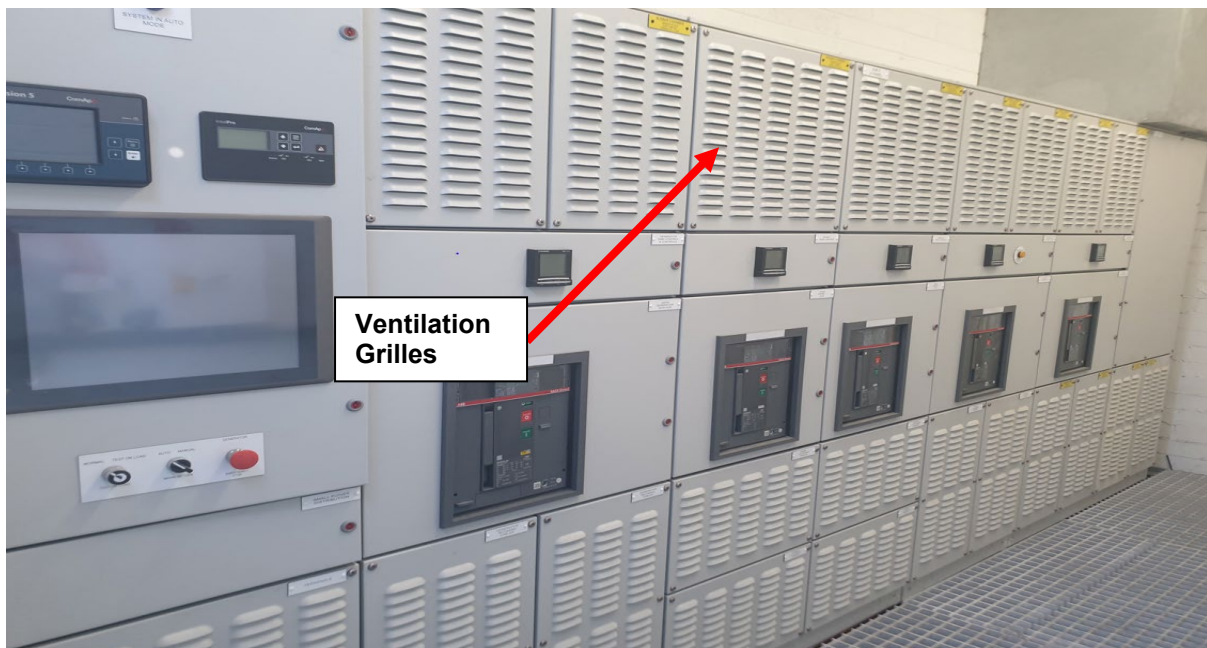
**CONTINUOUS
LABEL ON
SWITCHBOARD
ENCLOSURE
(BLACK IN
COLOUR)**

5.20. The current rating of the copper busbars must be such that :-

- The busbar must carry the full load current at a maximum temperature of 30 degrees over ambient throughout. A full temperature rise calculation is to be submitted prior to approval of workshop drawings.
- The busbar system shall be fully type tested in compliance with EN 60439-1 and utilise all proprietary connections.
- To eliminate Eddy Currents within the board, non-magnetic (stainless steel/Aluminium) busbar holders shall be utilised.
- The Busbar shall be FULLY rated throughout the switchboard.
- Neutral Busbar shall be the same size as the phase busbar.
- Copper Busbars acceptable only, not aluminium

5.21. To facilitate heat dissipation from the switchgear, the front panels shall come complete with suitable ventilation grilles as shown. Grilles shall be installed in accordance with standards. The following switchboard shall incorporate this:

5.21.1. OLB1.



6. TYPICAL EQUIPMENT TO BE INCORPORATED INTO MAIN SWITCHBOARDS FOR STANDBY GENERATOR OPERATION

GENERAL:

- 6.1. The following equipment is to be incorporated into OLB1 associated with standby generator operation by the LV Electrical Contractor:
- 6.2. The LV Electrical Contractor shall be responsible for the design of the entire control strategy for each of the 2 No. future standby generator systems in accordance with the proposed control philosophy document issued as part of the tender documents.
- 6.3. The LV Electrical Contractor shall supply and install all equipment to ensure the system operates in accordance with the existing and proposed control philosophy.
- 6.4. The LV Electrical Contractor shall prepare a detailed and comprehensive control document including drawings as part of the contract.
- 6.5. All components to be installed within the main switchboards associated with the standby generator operation shall be a ComAp product. This is to ensure full integration of the new standby generators into the existing hospital site wide standby generator network.
- 6.6. All cabling to be integrated into the main switchboard for controlling the standby generator systems shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks.
- 6.7. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist as part of the contract. The LV Electrical Contractor shall also be responsible for the supply and installation of all external cabling and for issuing out schematic drawings clearly identifying all wiring requirements.
- 6.8. The primary trip shall be via the sub-station Transformer ACB. The secondary G10 trips shall be via the transformer MV breakers.
- 6.9. **EQUIPMENT/WIRING TO BE INSTALLED WITHIN THE SWITCHBOARD TO FACILITATE GENERATOR OPERATION**

GENERATOR 1

- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

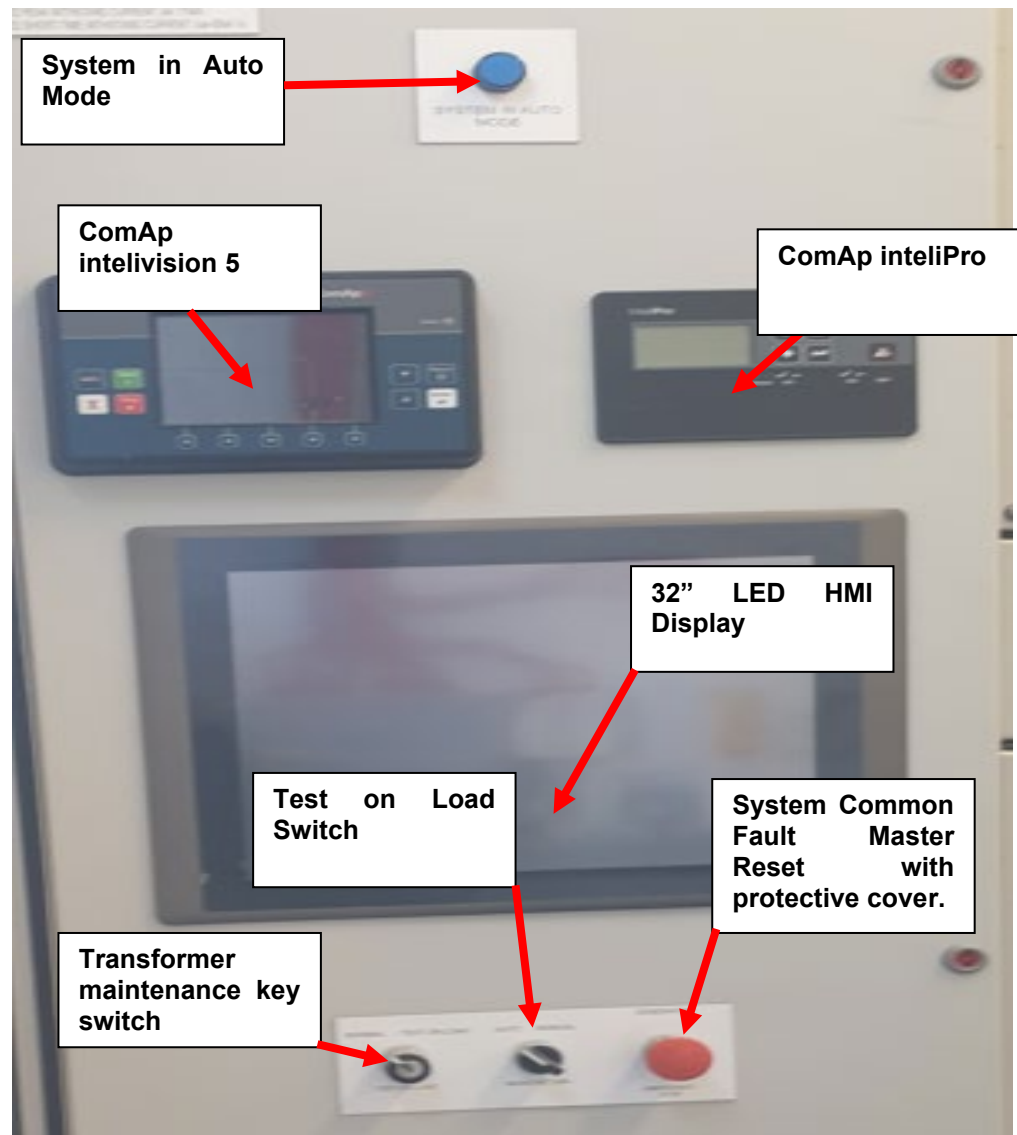
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- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

MAINS

- ComAp Inteli Pro Controllers (G10 Controller).
- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.
- 32" LED HMI display shall be installed in the main new switchboard to associated with the Generator control philosophy system.

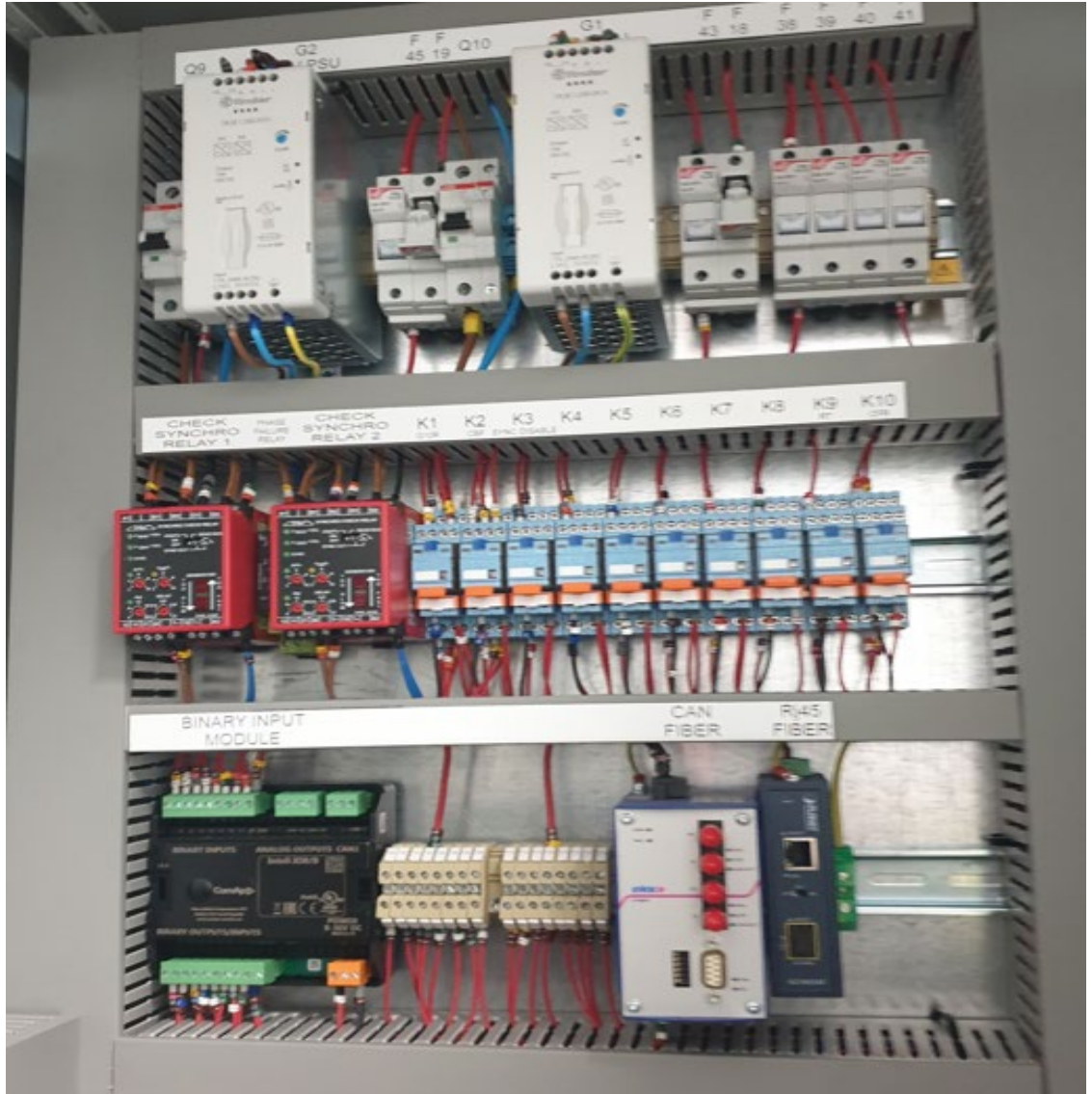
Note: All components must be a ComAp system to allow full integration into the existing ComAp standby generator hospital network.



TYPICAL MAIN SWITCHBOARD PANEL FACE.

The Off-Loading Switchboard OLB1 shall incorporate the following:

- **Test on Load Switch:** To allow standby generator system to automatically synchronise with the sub-station supply and operate in short term paralleling. When switch returned to normal position the standby generator system will again automatically synchronise with the sub-station supply and automatically return the sub-station to the normal supply.
- **Transformer Maintenance:** To allow the transformer to be maintained without loss of power to sub-station.
- **System Common Fault Master Reset** push button with protective cover.



TYPICAL NEW MAIN SWITCHBOARD COMPONENTS ARRANGMENT

ComAp
The heart of smart control



Datasheet



Order code: INTELIPRO

Protection Relay for Parallel Applications

Product description

InteliPro is highly flexible protection relay for grid connected applications like generator sets, renewable energy sources, cogeneration, micro turbines, etc.

Key functions

- > Voltage, frequency and current based protections for on-grid distributed power generation

Key features

- > True RMS measurement
- > 3-phase voltage and current measurement
- > Automatic fault reset with adjustable time delay
- > Two stage protection settings
- > Optional functions for extended protection
- > Free assignment of 8 binary inputs, 9 binary outputs and 3 analog inputs
- > Full and easy configuration through the front panel or LiteEdit PC software
- > Expandable extensions and communication modules
- > Remote access
- > 3 level password protection
- > Event history log

Application overview



ComAp
The heart of smart control

**InteliGen NTC
BaseBox**



Order code: IG-NTC-BB
Gen-set Controller

Datasheet

Product description

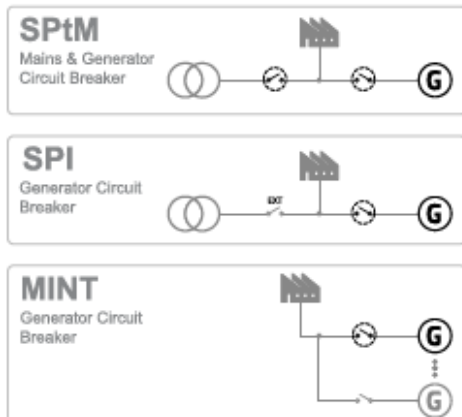
- ▶ Comprehensive paralleling gen-set controller
- ▶ Parallel operation up to 32 gen-sets
- ▶ High level control for complex systems
- ▶ CHP and gas engine controller

Key features

- ▶ Load sharing and VAR sharing via CAN
- ▶ Virtual shared inputs and outputs via CAN
- ▶ Support of wide range of applications
- ▶ Single or multiple gen-sets in parallel to mains operation with automatic back up function, multiple island operation
- ▶ Advanced power management function
- ▶ Customizable load control in parallel to mains
- ▶ Wide range of ECU support
- ▶ Extended communication capabilities
 - Built-in web server
 - Full Modbus slave support
 - GPS and AirGate support and more
- ▶ Highly configurable
 - Timers, Internal PLC, Force values and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Active e-mail messaging and SMS

- ▶ Extensive built-in protection functions
 - Standard protections
 - User configurable protection
- ▶ Extendable with ComAp's extension modules

Application overview



ComAp
The heart of smart control

**InteliMains
NTCBaseBox**



Order code: IM-NTC-BB

Comprehensive switchgear controller

Datasheet

Product description

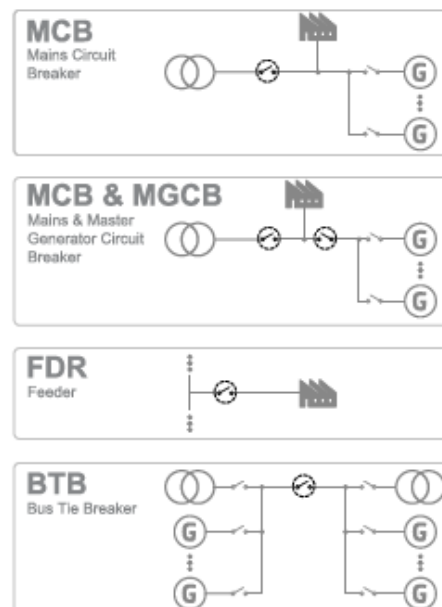
- ▶ Comprehensive switchgear controller
- ▶ Built-in control for up to 32 logic groups divided by Bus Tie Breakers
- ▶ High level control for complex systems

Key features

- ▶ Built-in breaker control
- ▶ Genset group synchronization, Loadsharing and Varsharing via CAN2
- ▶ Customizable load control in parallel to mains
- ▶ Extended communication capabilities
 - Built-in web server
 - Airgate support and more
- ▶ Highly configurable
 - Timers, internal PLC, Force value and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Monitoring and configuration with ComAp's PC tools
- ▶ Extensive built-in protection functions
 - Undervoltage, overvoltage
 - Underfrequency, overfrequency and more
- ▶ Full Modbus slave support (RS232)
- ▶ Extendable with ComAp's extension modules

- ▶ True RMS (TRMS) is used with Voltage, Current and Power measurement

Application overview



7. GENERAL:

- 7.1. The following is a general description of the control philosophy required for OLB1.
- 7.2. The contractor shall prepare a detailed and comprehensive control document including drawings for the hospital.
- 7.3. The control philosophy applies to the FUTURE standby generator, the proposed new standby generator and integration into the MV/LV switchgear.
- 7.4. The afore mentioned control and protection equipment shall be incorporated into OLB1 by the switchgear specialist, to allow the FUTURE generator to synchronise with network.
- 7.5. The contractor shall supply and install a control system to provide the control of the standby generators as identified herein.
- 7.6. All internal wiring from the controllers to ACB, relays etc shall be provided by the switchgear specialist as part of the contract.
- 7.7. All external cabling to be integrated into the main switchboard for controlling the system shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist.
- 7.8. All Main ACBs should have a 24V DC shunt opening coil and 230V shunt opening coil powered from the generator voltage and wired to the G10 controls.
- 7.9. Mains LV ACBs should have closing coils powered from mains.
- 7.10. Generator ACBs should have 230V UVR opening coil powered from the generator voltage and wired to two sets of terminals (one for generator controls and one for G10 controls).
- 7.11. Generator ACBs should have a 230V closing coil powered from the generator voltage.
- 7.12. All ACBs should have charging motors powered from the respective voltage.
- 7.13. 3 N/O & 2 N/C auxiliaries shall be installed on the mains ACBs and generator ACBs complete with tripped and racked out status.
- 7.14. Mains current 6 wires should be available from 5A measurement current transformers for the generator controllers.
- 7.15. Mains voltage should be available 3PH and N from 6A fuses.
- 7.16. 4 wire 400V 32A supply is required for generator auxiliary supplies.

- 7.17. Check synch /dead Bus relays required across each mains ACB, Generator ACBs and Coupler ACB.
- 7.18. Secondary G10 trips shall be via the transformer MV breakers MV1 and MV2. MV breakers shall come complete with relays/contactors etc for this function.

8. GENERAL CONTROL STRATEGY

Index of “Normal” Scenarios

- Normal operation: ESB supply healthy
- Mains /ESB Fails
- Mains return
- Brief Mains/ESB failure
- Test Off load
- Transfer to Generator / Test on Load
- G10 operation short term parallel
- Generator maintenance – safe isolation method.

Index of “Abnormal” or failure Scenarios (What if?) (the below scenarios are not included at this time but these and other what ifs! Can be implemented)

- ESB supplying load, mains fail. Mains ACB fails to open.
- Main ESB Circuit breaker trips on overload, system in Automatic, Generator not running
- Main ESB Circuit breaker opens OR is opened, system in Automatic, Generators not running
- Generator failure.
- MV Generator failures during a power failure.
- Site supplied by generator, Mains return sequence and Mains ACB Fails to close.
- Site supplied by generators, Mains return sequence - Gen breaker fails to open
- Site supplied by generators, LOSS OF COMMS FROM MASTER SYSTEM.
- Site supplied by Mains, LOSS OF COMMS FROM MASTER SYSTEM.

“Normal” Scenarios

Normal operation: ESB supply healthy

External Events	CONTROL SYSTEM ACTIONS
Mains Healthy and supporting site load	• Mains circuit breaker MCB closed • LV generator 1 not running • LV generator 2 not running • System in Auto • Generator circuit breaker (GCB) open • Site load supported from ESB supply • Mains MV healthy

Mains /ESB Fails

External Events	CONTROL SYSTEM ACTIONS
Mains failure: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • When synchronised the generator ACB's close. • Standby power LV generators 1 & 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generators 1 & 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy
External Events	CONTROL SYSTEM ACTIONS
Mains Manual Return if running on generators: Keyswitch in Manual position ComAp controller detects ESB within set-point limits	• When ESB Mains is available again system waits for 15 minutes before any action • LED indicates ESB Healthy • Key-switch in Position 1 "Manual return" • Operator chooses to restore Mains by turning Key-switch into position 0 "Auto return" • Main ACB closes under synchronous conditions i.e. (no blip return to mains/MV gens) • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cool down cycle. • Site load supported from ESB supply • Mains MV healthy

Brief Local Mains Failure

External Events	CONTROL SYSTEM ACTIONS
Mains failure: ComAp controller detects ESB set-point limits	• System waits for 5 seconds to see if ESB supply restores • If mains ESB returns under 5 seconds, then no action • Mains circuit breaker MCB does Not Open • System in Normal Operation

Test Off load for Service checks

External Events	CONTROL SYSTEM ACTIONS
Operator to change Genset controller from Automatic mode into Manual mode	• The operator will push the mode button from Auto to Manual • The operator will push the gen start pushbutton • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • Operator can note down generator parameters and carry out generator running checks • Note: NO Interruption to supply
Operator to change Genset controller from Manual mode to Automatic mode	• The Operator will push the gen stop pushbutton • The generator will go into cooldown and stop after a few minutes • If the Operator wants a sudden stop just press the gen stop pushbutton and the cooldown cycle will cancel and the generator will stop straight away • System reverts back to "Normal" • Operator to return generator controller from manual to automatic mode • Note: NO Interruption to supply

Transfer to Generator / Test on Load

External Events	CONTROL SYSTEM ACTIONS
Key switch : Position 1	• The operator will select key switch to position 1 for “Test on load” • After time period generator starts • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • LV generators 1 & 2 synchronises with mains supply and closes the generator ACB's • Generator ramps up on power and takes up the OLB2 site load • OLB2 LV ACB Opens • Standby power now powering OLB2 load • Note: No Interruption to supply
Key switch : Position 0	• The operator will select key-switch to position 0 for “Normal operation” • Test on load condition cancels • SUB3 LV MCB closes under synchronous conditions i.e. (no blip return to mains) • Site Supported on ESB Mains supply • Generator ramps down and GCB • Generator cools down and stops after a few minutes • System reverts back to “Normal”

G10 Protection – short term parallel

External Events	CONTROL SYSTEM ACTIONS
Generator in parallel with mains for short duration. Mains disturbance causes G10 protection to operate.	- G10 protection is “active” during parallel connection only - G10 protection operates (Trip condition) LV ACB is opened by G10 panel, site load supported from Generator - Generator continues to run on load until G10 fault is reset NOTE: if OLB2 LV ACB fails to Open on G10 fault then G10 control system will Open SUB3 10kv breaker as a secondary trip (per ESB G10 regulations). Manual restore required.
Recovery procedure: G10 manually reset at G10 panel Key switch for manual/auto return to mains to be in the AUTO position	- Operator will select “KS1” from “Test on load” position 2 back to “normal position” 0 - Test on load condition cancels - LV MCB closes under synchronous conditions i.e. (no blip return to mains/MV gens) - Site Supported on ESB Mains/MV gens supply - Generator ramps down and Opens ACB - Generator cools down and stops after a few minutes - System reverts back to “Normal”

Generator maintenance – safe isolation method.

External Events	CONTROL SYSTEM ACTIONS
Generator Maintenance Generator Controller – Pushbuttons Position 0 OFF	- Press the Estop on the generator control panel - This will render the entire system control unavailable for operation - Manually Open Set mounted circuit breaker - When works are complete return system back into automatic by reversing the above procedure - Ensure system is back in Automatic and No alarms

“Abnormal” Scenarios

ESB supplying load, mains fail. ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
ACB fails to Open	OLB2 Generator will not close ACB in this situation and bring up a breaker fail to operate alarms Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker MCB trips on overload, system in Automatic, Generator not running.

External Events	CONTROL SYSTEM ACTIONS
ACB Trips Open	Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker ACB opens OR is opened, system in Automatic, Generators not running.

External Events	CONTROL SYSTEM ACTIONS
Mains ACB Opens OR is Opened	If Mains ACB breaker opens for NO reason that System is aware of then generator control system will reclose the Mains ACB. If Operator wants to Open Mains ACB then he must put generator control system into Manual mode

Mains /ESB Fails, Generator Fails.

External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 1 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 2 run up to stable speed and voltage. • Generator 2 ACB close. • Standby power LV generator 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 2 shall back off, and the mains supply will take up the load. • Generator 2 ACB's open. • Generators 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer
External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 2 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 run up to stable speed and voltage. • Generator 1 ACB close. • Standby power LV generator 1 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 1 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 shall back off, and the mains supply will take up the load. • Generator 1 ACB's open. • Generators 1 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer

Site supplied by generator, Mains return sequence and ACB Fails to close.

External Events	CONTROL SYSTEM ACTIONS
ACB Fails to Close	Maintenance engineers to investigate issue and repair. Generator control system will stay running on Generator until MCB is successfully Closed by control system

Site supplied by generators, Mains return sequence - Gen breaker ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
GCB Fails to Open	Maintenance engineers to investigate issue and repair. If ACB fails to Open after a three attempts generator will shut down and generator set mounted breaker should be opened so fault can be identified and rectified.

VOLT frees available to Others

Modbus connection is available from the generator Comap controller.

Volt free contacts are available from the generator up to a maximum of 4 without the need to add an expansion card to the generator control system.

Volt free contacts are available directly from the generator bulk fuel tank for tank level monitoring and bund leak.

These volt free signals are available to go to local BMS outstation.

VOLTFREE	Type	Comment
Gen running	DO	Signal closed = Generator running
Gen fault	DO	Signal closed = Generator fault
Genset NOT in Auto	DO	Signal open = Genset NOT in Auto
Fuel tank level low	DO	Signal closed = Fuel low
Fuel tank reorder level	DO	Signal closed = Fuel reorder
Fuel tank bund leak	DO	Signal closed = Bund leak
Modbus connection		Generator to Customer BMS

Engine Controller Configuration – generator controller.

Engine Inputs	CONTROL Function
- Emergency Stop - Oil Pressure - Water Temperature - Generator Circuit Breaker Status - Radiator Level - Over speed	Normally fail safe emergency stop circuit Digital Engine Low Oil Pressure Switch Digital Engine High Water Temperature Switch Status of the synchronising breaker; open and closed Digital input for Water Level (If available) Over speed
Engine outputs	CONTROL Function
- Fuel Solenoid - Electronic Governor - Starter Motor - Battery Charger On / Off control - Engine Heater On / Off control	Output to open the engine fuel for starting Power source for Speed controller, same configuration as Fuel solenoid Starter motor with adjustable RPM disconnect Disconnect battery charger on engine start / crank Disconnect Engine Heaters on engine start / crank
Engine Analogue Inputs	CONTROL Function
- Oil Pressure - Water Temperature - Engine Speed RPM - Generator Voltage - Generator Current	Engine mechanical protection; Low Oil Pressure Alarm & Shutdown Engine Mechanical protection; High Engine Water Temperature Alarm and Shutdown Engine speed derived from flywheel teeth Generator Bus Voltage reference; Voltage after generator synchronising breaker Generator Current Measurement
Engine Analogue Outputs	CONTROL Function
Not required	

9. CIRCUIT INDEX CHARTS:

- 9.1. Circuit index charts contained in clear plastic sealed containers shall be adhesive-fixed inside the door of every distribution board.
- 9.2. The index shall fully identify and describe each circuit protected.
- 9.3. The index shall also identify the neutral connections for the outgoing circuits which must be connected in sequence to correspond with the phase conductor of the circuit.
- 9.4. The Contractor shall include for the supply and fixing of all circuit index charts and plastic envelopes.

10. CABLE DISTRIBUTION SYSTEM:

- 10.1. From the LV switchgear, the Contractor shall install a complete low voltage distribution network as specified hereafter.
- 10.2. Distribution cabling shall be protected against damage during installation.
- 10.3. All cables shall be permanently clipped and connected before being commissioned.
- 10.4. All cables shall be sized as shown on the drawings.
- 10.5. Cable insulation considerations shall comply with section 527 of I.S. 10101 wherein, all buildings shall as a minimum meet the requirements of Class Dca S2, d2, a2 or higher in accordance with I.S. EN 50575. In addition, cables shall be tested in accordance with I.S. EN 61034-2 and the smoke generated shall result in transmittance values of not less than 60%.
- 10.6. Cables shall be installed using cable tray, as indicated on the drawings.
- 10.7. Cables installed using cable tray may be secured with nylon cable ties. The size and spacing of the ties shall be in accordance with the cable manufacturers' requirements.
- 10.8. Single runs of cable shall be secured by claw type cleats single bolt or two bolt fixing as required, complete with studs and backstrap.

- 10.9. The arrangements route, size and types of LV distribution cables shall be as indicated on the drawings and shall be marked out on site by the Contractor for approval by the Engineer on site before the installation commences. The selection of wiring systems shall comply with part 52 of I.S. 10101. In respect to neutral conductors and their cross-sectional area(s), clause 524.2 must be adhered to.
- 10.10. Primary distribution routes are indicated on the drawings but the Contractor shall make due allowance for deviations from or detours to these routes arising from co-ordination activities or other parameters.
- 10.11. Each cable shall be manufactured for installation in a continuous length and shall not be jointed without written authorisation from the Engineer.
- 10.12. Glands for SWA type cables shall contain a plain brass slip-on earth tags shall be provided; above this cable size glands shall have an integrally cast earth lug. Shrouds to totally enclose the gland body and form an effective seal down onto the cable's overall sheathing shall be provided. Tags and lugs shall be made off to supplement earthing provided directly by glands.
- 10.13. All electrical circuits shall include a separate earth conductor (protective earth) with yellow/green outer sheath, of appropriate insulation (in accordance with section 527 of I.S. 10101).
- 10.14. Each distribution group shall be solidly bonded to the cable gland of each incoming and outgoing cable and to cable trunking. Special care shall be taken to ensure that effective electrical and mechanical connections are obtained.
- 10.15. For tendering purposes it shall be assumed that all wiring shall be brought directly to the terminals of the appropriate protective device and to the corresponding connector ways on the relevant neutral and earth bar(s) where relevant.

11. METAL CABLE LADDER / TRAY AND FITTINGS:

11.1. MATERIALS:

- 11.1.1. Cable ladders shall be of the heavy duty type in accordance with IS EN 61537
- 11.1.2. Perforated cable tray shall be heavy duty type formed from galvanised sheet steel IEC 61084.

- 11.1.3. For tendering purposes the dimensions shall comply with the table below unless stated otherwise on drawing.

Nominal Width	Minimum Height of Upstand	Nominal Thickness of Steel Sheet	Application
100mm	50mm	1mm	Internal Installations
150mm	50mm	1mm	Internal Installations
225mm	50mm	1.5mm	Internal Installations
300mm	50mm	1.5mm	Internal Installations
450mm	50mm	1.5mm	Internal Installations
600mm	50mm	1.5mm	Internal Installations
100mm	50mm	2.5mm	External Installations
150mm	50mm	2.5mm	External Installations
300mm	50mm	2.5mm	External Installations

- 11.1.4. Bends, tees, sets etc., shall be of the same manufacture as the cable tray and of the same material.
- 11.1.5. Where cable tray is installed in corrosive atmospheres (Battery Rooms etc.) it shall be coated with insulation in accordance with section 522 and in particular, 522.5 of I.S. 10101.
- 11.1.6. Mushroom-head sheradised or cadmium plated bolts and nuts shall be used for fabricating cable tray and accessories.

11.2. INSTALLATION OF CABLE TRAY:

- 11.2.1. Cable tray shall be secured in a neat and tidy manner and shall be secured with adequate mushroom-head or round head sheradised or cadmium plated screws fixed at regular intervals not exceeding 1.0 m. At bends or tees tray shall be supported adjacent to the overlap point. Cable tray installations shall comply with section 521 and Annex 52A of I.S.10101.
- 11.2.2. Metal spacers - 25 mm minimum - shall be used to distance the cable tray from vertical and horizontal surfaces.
- 11.2.3. Changes of direction of cable tray shall be curved to ensure continuous support for all cables.
- 11.2.4. Cable tray runs shall be determined by the Contractor and agreed with the responsible Engineer before work is started.

- 11.2.5. Cable tray shall be spaced at least 150 mm clear of piping and ducting related to other services, and installation shall be such that the wiring system is in compliance with section 528 or I.S. 10101.
- 11.2.6. Joints on cable tray shall overlap by at least 100 mm. Alternatively manufacturer approved joiners can be used.
- 11.2.7. All cables installed on cable tray in horizontal and vertical planes shall be adequately secured with straps or clips at close intervals to prevent sagging.
- 11.2.8. Where cables pass through holes in cable tray. The holes shall have a bush and lock-ring arrangement.
- 11.2.9. Where welding has been employed in the fabrication of cable tray the joints shall be treated with two coats of zinc rich paint.
- 11.2.10. Manufacturers standard accessories shall be used throughout. However, where special non-standard accessories are required, they may be manufactured by the Contractor with the approval of the responsible engineer.
- 11.2.11. Cable tray shall not be cut through perforations if possible. All raw edges shall be filed and treated with two coats of zinc rich paint.
- 11.2.12. Where cable tray penetrates through floors and walls, fire barriers shall be provided by the Main Contractor, manufactured from insulating material, shall be so rated as to retain the integrity of the fire compartment and sealing of wiring system penetrations shall be in accordance with clause 527.2 of I.S. 10101.

12. CABLE TRUNKING AND FITTINGS:

12.1. MATERIALS:

- 12.1.1. Surface cable trunking shall comply with I.S. EN 50085 and be manufactured from galvanised steel with electrically deposited zinc.

12.2. The metal gauge shall conform with the following table:-

Dimensions mm		Body Gauge mm	Cover Gauge mm
A	B		
50 x 50		1.0	1.0
75 x 50		1.2	1.0
75 x 75		1.2	1.0
100 x 50		1.2	1.2
100 x 75		1.2	1.2
100 x 100		1.2	1.2
150 x 75		1.6	1.2
150 x 100		1.6	1.2
150 x 150		1.6	1.2
200 x 75		1.6	1.2
200 x 100		1.6	1.2
200 x 150		1.6	1.2
200 x 200		1.6	1.2
225 x 75		1.6	1.2
225 x 100		1.6	1.2
225 x 150		1.6	1.2
225 x 225		2.0	1.2
300 x 75		1.6	1.6
300 x 100		1.6	1.6
300 x 150		2.0	1.6
300 x 225		2.0	1.6
300 x 300		2.0	1.6

12.2.1. Joints shall be bonded with couplings and purpose made copper earth continuity links.

12.2.2. Where paint finish trunking is required, epoxy powered coating shall be used.

12.2.3. Manufacturers standard fittings shall be used throughout. However, where special fittings are required they shall be manufactured off site to approved drawings and to the same specification as standard items.

12.3. INSTALLATION OF TRUNKING:

12.3.1. Trunking shall be erected in a neat and tidy manner and shall be secured with adequate round head sheradised or cadmium plated screws fixed at regular intervals not exceeding 1.8 m and trunking installations shall comply with clause 521.6 and Annex 52A of I.S.10101.

12.3.2. Trunking shall be run neatly on the surface of the building(s) and truly vertical, horizontal or parallel with the features of the building.

- 12.3.3. Metal spacers - 25 mm minimum - shall be used to distance the trunking from vertical.
- 12.3.4. For horizontal runs trunking should be supported by a trapeze network so that the lid of the trunking is not required to hold up the cables. Alternatives to this are only with the written consent of the engineer.
- 12.3.5. The interior of all trunking shall be free from burrs, sharp edges and swarf.
- 12.3.6. Trunking runs shall be determined by the Contractor and agreed with the Engineer before work is started.
- 12.3.7. Trunking shall be spaced at least 150 mm clear of piping and ducting of other services, where practical.
- 12.3.8. Conduit connections to trunking shall be made with standard flange couplings and lead washers.
- 12.3.9. Cable pin racks shall have PVC sleeved pins. These shall be used on vertical runs and be provided at 3 m intervals.
- 12.3.10. Lighting trunking shall be 50 mm x 50 mm manufactured from 1.2 mm galvanised steel with matching fittings.
- 12.3.11. Connections between trunking and distribution boards shall be sized to accept cables from all used and "spare" ways.
- 12.3.12. The space factor capacity of trunking shall be 45% of the internal cross-sectional area.
- 12.3.13. Where horizontal runs of trunking pass through walls or partitions, the internal free space surrounding cables shall be fire-stopped with glass fibre, mineral wool, or other approved proprietary packing material to the full thickness of the wall. Such fire-stopping shall be carried out by the Contractor.
- 12.4. Standard flanged couplings shall be used to terminate trunking at apparatus, at adaptable boxes and at points where it is desired to connect one section of trunking to another where a standard fitting is obviously unwarranted. The practice of cutting and bending the material of the trunking to form flange attachments will not be accepted.
- 12.5. Connections between trunking and apparatus shall be by a screwed coupler and bush, or a standard flange coupling or an adapter neck, fabricated or cast. Direct attachment of trunking to apparatus will only be permitted if cable entries are provided with smooth bore bushes or grommets and the return edge of the lid of the trunking is left intact.
- 12.6. Holes in trunking shall be drilled, punched or cut by ring saw.

- 12.7. Trunking in the vertical rising ducts shall be fixed to the unistrut spacers provided by the Contractor with sheradised Whitworth cheese head screws and unistrut nuts, two per fixing. Trunking run in ceiling spaces and roof voids shall be fixed in a similar manner.
- 12.8. All compartmented tee pieces and intersection units shall have their compartments fully screened and separated from each other and the effective cross sectional areas of these branches shall not be reduced.
- 12.9. Cable trunking in vertical ducts shall be installed with the cover pointing outwards and all trunking installed in ceiling spaces shall have the cover pointing downwards, unless agreed otherwise.
- 12.10. In the areas where the unistrut inserts are available fixed to the concrete slabs, the Contractor shall be free to use them for fixing cable tray, etc., and in all other areas the Contractor shall use rawlbolt anchors for fixing hanger brackets.
- 12.11. Trunking may be fitted under false floor in some areas as indicated. This trunking shall be installed with lid facing upwards.

13. DISCRIMINATION STUDY:

- 13.1. The contractor shall include for a complete MV/LV discrimination study to be carried out as part of the contract. The contractor shall appoint a specialist as part of the contract to complete the study as part of the contract.
 - 13.1.1. The discrimination study shall be based on the final manufacturer's protective devices.
 - 13.1.2. The survey shall be carried out using the manufacturer's discrimination software from the ESB input point on the MV side through to the final outgoing circuits on the LV side.
 - 13.1.3. ESB will make available their setting at the client interface point to the hospital.
 - 13.1.4. The discrimination study should grade both the MV and LV network based on these values.
 - 13.1.5. A report shall be submitted to the Engineers clearly identifying the discrimination study exercise and the settings for all protective devices on the MV & LV network.
 - 13.1.6. Once all values have been agreed with the Engineers, the contractor shall arrange for all settings to be programmed into the MV/LV networks protective devices.
 - 13.1.7. The contractor shall include within their tender for the complete discrimination exercise to be carried out as above by a suitable specialist as part of the contract.

14. MAIN LV SWITCHBOARD STRUCTURAL SUPPORT SYSTEM:

- 14.1. The floor of the new LV room shall not incorporate a trench. A steel grated floor is installed within the main LV switchroom approximately 1,000mm above the floor level. (This grated floor is only capable of supporting persons within the room but NOT equipment). This arrangement is to facilitate the new LV cables entering and leaving the room from the new main switchboard. It is also to facilitate future maintenance etc.



- 14.2. The main switchboard will therefore need to be positioned on a purpose build switchboard steel support system along its entire length (U-Shaped) that will be approximately 1,000 meters above the floor of the main LV switchroom.
- 14.3. The contractor shall arrange for a chartered structural engineering practice as part of the contractor to design and certify a suitable structural steel support system to run along the entire length of the switchboard.
- 14.4. The chartered structural engineer shall review the design of the new main switchboard with the contractors switchgear manufacturer to ensure the correct weights, dimensions, cable entry/exit points, heights etc are agreed to ensure the support system does not in any-way impact on the operation of the new main switchboard.
- 14.5. The rear of the new main switchboard will be positioned on the 200mm concrete rebate at the walls.
- 14.6. The structural steel support system shall be suitably secured to the floor of the switchroom.
- 14.7. The contractor shall arrange for the structural steel support system to be manufactured, certified and installed in accordance with the structural engineers design.

- 14.8. The entire structural support system shall be galvanised.
- 14.9. The contractor shall include for the cutting/shaping of the heavy duty steel floor to facilitate the steel support system as part of the contract.
- 14.10. The entire system shall be earthed in accordance with IS 10101:2020 standards.
- 14.11. The contractor shall include for the supply, design, manufacture, installation, certification of the entire structural support system as part of the contract.

15. MAIN MEDIUM VOLTAGE SWITCHGEAR STRUCTURAL SUPPORT SYSTEM:

- 15.1. The floor of the new MV room shall not incorporate a trench. A steel grated floor is installed within the main MV switchroom approximately 1,000mm above the floor level. (This grated floor is only capable of supporting persons within the room but NOT equipment). This is to facilitate the new MV cables entering and leaving the room from the new MV Switchgear. It is also to facilitate future maintenance etc.



- 15.2. The MV switchgear will therefore need to be positioned on a purpose build switchboard steel support system along its entire length that will be approximately 1,000 meters above the floor of the main MV switchroom.
- 15.3. The contractor shall arrange for a chartered structural engineering practice as part of the contractor to design and certify a suitable structural steel support system to run along the entire length of the MV Switchgear.
- 15.4. The chartered structural engineer shall review the design of the new MV switchgear with the contractors MV switchgear manufacturer to ensure the correct weights, dimensions, cable entry/exit points, heights etc are agreed to ensure the support system does not in any-way impact on the operation of the new MV switchgear.
- 15.5. The rear of the new MV Switchgear switchboard will be positioned on the 200mm concrete rebate at the walls.
- 15.6. The structural steel support system shall be suitably secured to the floor of the MV switchroom.

- 15.7. The contractor shall arrange for the structural steel support system to be manufactured, certified and installed in accordance with the structural engineers design.
- 15.8. The entire structural support system shall be galvanised.
- 15.9. The contractor shall include for the cutting/shaping of the heavy duty steel floor to facilitate the steel support system as part of the contract.
- 15.10. The entire system shall be earthed in accordance with IS 10101:2020 standards.
- 15.11. The contractor shall include for the supply, design, manufacture, installation, certification of the entire structural support system as part of the contract.

16. CABLE CONTAINMENT SYSTEM WITHIN TRENCHES

- 16.1. The contractor shall include for the supply and installation of a cable containment system within the trenches.
- 16.2. Heavy duty galvanised steel cable ladders shall be installed within each trench.
- 16.3. A unistrut support system shall be supplied and installed by the contractor to support the containment within the trenches.
- 16.4. In general cable ladders shall be stacked above each other within the trench via the unistrut support system.
- 16.5. The lowest level cable ladder shall be positioned 100mm above the floor of the trench to ensure the cables are not installed within potential water ponding at the base of the trench.
- 16.6. All cables shall be supported on the ladders in a format to ensure eddie current are not induced. A suitable manufacturers cleat arrangement shall be provided to support the single core cables on the ladders.
- 16.7. The ladders and unistrut support system shall be earthed along the entire length of the run.
- 16.8. As the trenches shall be installed to include the cable cover lids in advance of the electrical contractor commencing works on site, the contractor shall include for the lifting of all the trench cover lids with a suitable lifting machine to facilitate the installation of cables, ladders and unistrut support system. Upon completion of the installation of the cables, the contractor shall include for the replacing of the trench cover lids with a suitable lifting machine and sealing of the cover surrounds.

17. CABLE CONTAINMENT SYSTEM WITHIN HEAVY DUTY STEEL FLOOR

- 17.1. The contractor shall include for the supply and installation of a cable containment system within the sub-station.
- 17.2. Heavy duty galvanised steel cable ladders and cable trays shall be installed.
- 17.3. The cable ladders shall enter the main LV switchroom from the trenches. The contractor shall coordinate the route of the cable ladders within the LV room over the the respective protective device locations within the new main LV switchboard. The contractor shall ensure that the ladders are installed so that access to the cables is possible at all times for maintenance purposes etc.
- 17.4. The cable ladders shall enter the main MV switchroom from the trenches & ESB room. The contractor shall coordinate the route of the cable ladders within the MV room over the respective protective device locations within the new main MV switchgear. The contractor shall ensure that the ladders are installed so that access to the cables is possible at all times for maintenance purposes etc.
- 17.5. As the grated steel floor shall be installed to include the cable cover lids in advance of the electrical contractor commencing works on site, the contractor shall include for the lifting of all the grated steel floor with a suitable lifting machine to facilitate the installation of cables, ladders and unistrut support system, switchboard structural steel support systems. Upon completion of the installation of the cables, the contractor shall include for the replacing of the grated steel floor with a suitable lifting machine.

18. CABLE CONTAINMENT SYSTEM WITHIN MAIN LV SWITCHROOM.

- 18.1. The contractor shall include for the supply and installation of a cable containment system within the sub-station.
- 18.2. Within the main LV Room, the heavy duty cable ladder from the trenches shall enter the LV switchroom and run over to the relevant part of the electrical switchboard.
- 18.3. The ladders shall be positioned within the floor of the LV room to ensure that it shall be possible to access the cables for future inspection etc.

19. POSITIONING OF ELECTRICAL PLANT.

- 19.1. The contractor shall include for the delivery to site and positioning in place of all MV switchgear, transformers, switchboards, power factor correction equipment local are switchboards etc as part of the contract.
- 19.2. The contractor shall appoint a crane company with suitable insurances and expertise as part of the contract to lift and position all electrical equipment in place.
- 19.3. The contractor shall appoint a suitable lifting company with suitable insurances and expertise as part of the contract to position all equipment within the relevant rooms as part of the contract.
- 19.4. The lifting in place of all equipment shall take place at night time only when the hospital is quiet. All cranes and lifting equipment shall only be put in place at night time to allow equipment to be lifted into place. The contractor shall include as part of the contract for this works to take place at night time only (between hours of 01.00H and 05.00H).

19.5. MV Switchgear.

- 19.5.1. The contractor shall include for delivery to site of all MV switchgear and positioning within the MV switchroom as part of the contract.
- 19.5.2. The contractor shall include for a suitably sized crane to drop the MV switchgear out side the new room. The contractor shall include for a suitable lifting company to position the MV switchgear in the MV room using suitable lifting equipment, sliding equipment etc as part of the contract.
- 19.5.3. It shall be necessary for the contractor to remove the grated floor to assist lifting in the equipment into the MV room and positioning on the permanent structural support system as identified elsewhere in the specification. The contractor shall include as part of the contract for the manufacture of a suitable steel table to assist moving and positioning of the MV switchgear in the room from the landing point outside the room.
- 19.5.4. The MV switchgear shall come in multiple sections to facilitate positioning in the MV switchroom.

19.6. LV Switchgear.

- 19.6.1. The contractor shall include for delivery to site of all LV switchgear and positioning within the Substation LV switchroom as part of the contract.
- 19.6.2. The contractor shall include for a suitably sized crane to drop the LV switchgear out side the new room. The contractor shall include for a suitable lifting company to position the LV switchgear in the LV room using suitable lifting equipment, sliding equipment etc as part of the contract.

- 19.6.3. It shall be necessary for the contractor to remove the grated floor to assist lifting in the equipment into the LV room and positioning on the permanent structural support system as identified elsewhere in the specification. The contractor shall include as part of the contract for the manufacture of a suitable steel table to assist moving and positioning of the LV switchgear in the room from the landing point outside the room.
- 19.6.4. The LV switchgear shall come in multiple sections to facilitate positioning in the LV switchroom.

19.7. Transformers.

- 19.7.1. The contractor shall include for delivery to site of the transformers and positioning within the transformer rooms as part of the contract.
- 19.7.2. The contractor shall include for a suitably sized crane to drop the transformers out side the new transformer rooms. The contractor shall include for a suitable lifting company to position the transformers in the transformer rooms using suitable lifting equipment, sliding equipment etc as part of the contract.

SECTION 3 - PARTICULAR SPECIFICATION

PART 3.2 - SMALL POWER SERVICES (62)

1. GENERAL SERVICE SOCKETS:

1.1. GENERAL

1.1.1. The wiring system shall be in accordance with section 527 of I.S. 10101 and for general service socket outlets shall be in conformance with

- Method 1 – DCA Approved 70 degrees Thermoplastic cables in conduit or trunking (section 15 and 16 (ELEC 06, section 2))
- Method 2 – NHXMH cables on cable tray (section 15 and 16 (ELEC 06, section 2))
- Method 3 – XLPE/SWA/ DCA Approved 70 degrees Thermoplastic cables on cable tray (section 15 and 16 (ELEC 06, section 2))

1.2. The Contractor shall supply and install a complete general service socket installation as indicated.

1.3. The installation shall be a dedicated trunking / conduit system with DCA Approved 70 degrees Thermoplastic cables.

1.4. Generally, conduits shall branch from the trunking and be saddled by means of spacer bar saddles to the underside of the floor slab continuing thus in the ceiling space and dropping down to the position of the sockets which may be located in the patent partition or concealed in concrete or block walls.

1.5. In all areas with corridor ceiling trunking the wiring from the distribution board shall be conveyed in the trunking to a point nearest to its final destination from whence it shall continue in conduit to the outlet.

1.6. All socket-outlets shall have a 2.5 mm² DCA Approved 70 degrees Thermoplastic earth wire, identifiable as per Table 51ZC.1 in I.S. 10101, installed with the circuit wiring from the distribution boards. Thus, each socket circuit shall have an earth conductor connecting from the earth socket terminal of the socket outlet back to an earthing bar which shall be incorporated in the distribution group.

1.7. Conduits serving general service socket-outlets on benches shall drop from the ceiling void in an agreed location and manner and connect to a spine trunking or conduit running beneath the worktop. Final connections to pedestal units shall be by means of flexible conduit.

- 1.8. Final circuits for general purpose socket-outlets shall be as indicated or as approved. The wiring system used shall be DCA Approved 70 degrees Thermoplastic cables in trunking and/or conduit as specified in Section 2 of this Specification. Cables shall be 4 mm² stranded) with 20A/30mA RCBO (Type B) protection with a maximum of 4 no. outlets per circuit unless otherwise indicated.
- 1.9. Cleaning outlets, catering outlets and isolators and other items of permanently wired equipment shall be engraved with their intended usage and labelled with the circuit reference.
- 1.10. Where metallic outlet plates are installed on plaster walls, a plastic membrane shall be inserted between plate and plaster to prevent a chemical reaction between metal and plaster and consistent with manufacturer's instructions.
- 1.11. SOCKETS:
 - 1.11.1. General service socket outlets shall be 13 amp three-pin socket and shall comply with the latest IS 411 standard. Socket outlets shall be 13A 3 pin with integral single/double pole switch and shall comply with the section 554 of I.S. 10101. Socket outlets shall have integral single pole switches unless stated otherwise. Interlocked shutters shall be incorporated in all sockets.
 - 1.11.2. In accordance with clause 554.1, socket outlets for general purposes shall be mounted at a height not lower than 400 mm and not higher than 1200 mm above floor level. Socket outlets shall be mounted at 450 mm from the floor level unless particular requirements dictate otherwise . The sockets shall be as manufactured by Lewden, Legrande, Marechal, or equal and approved.
 - 1.11.3. Weatherproof socket outlets (13A externally rated, IP54) shall be provided with spring-loaded covers or screw on metal caps as scheduled. They shall comply with the latest BSS.

SECTION 3 - PARTICULAR SPECIFICATION

PART 3.3 - LIGHTING SERVICES (63)

1. GENERAL LIGHTING:

- 1.1. The Contractor shall install a complete lighting scheme in each area as indicated on drawings and specified hereafter.
- 1.2. The following specification covers general lighting circuits, general luminaires, emergency lighting circuits, emergency luminaires, illuminated signs and other specialised lighting.
- 1.3. The lighting installation is designed generally in accordance with the SLL Code for Lighting and is cognisant of the minimum requirements outlined in IS EN 12464 part 1 and 2 where required.
 - 1.3.1. The Contractor shall include for handling, erecting, installing, and connecting all luminaires and accessories (e.g., transformers etc.) shown on the drawings, whether they are supplied as part of this contract or not.

2. WIRING:

- 2.1. The wiring shall be in a metal trunking and/or steel conduit throughout with the trunking generally being located in the ceiling spaces, facing upwards with the lid at the top, and connected to the distribution boards in the distribution cupboards. The Contractor shall allow sufficient bends, tee sets, offsets, reducers, suitable trapeze work (where required) etc. to make the interface in a workmanlike manner to the Engineer's approval.
 - 2.1.1. Wiring systems for lighting installations shall be in accordance with section 559.5 of I.S 10101
- 2.2. Unless otherwise indicated, the branch conduits shall rise from the trunking and be secured by means of spacer bar saddles to the underside of the floor slab thence dropping where necessary to light outlet boxes in walls and ceiling spaces.
- 2.3. Final lighting sub-circuits shall be wired in 2.5 mm², stranded copper conductor LSOH insulated cables with 10A protection. The MCB/RCBO characteristic shall be selected to conform with section 533 and more specifically, clause 533.3.2.2 of IS 10101.

- 2.4. The wiring shall be so arranged that not more than two 2.5 mm² cables enter any one terminal.
- 2.5. It shall be noted that 5 amp socket outlets intended for lighting circuits only including lighting circuits within bathrooms, shall be protected by RCBs in accordance with clause 701.415.1 of I.S. 10101.
- 2.6. The Contractor shall arrange the circuiting of the lighting systems as indicated on drawings.
- 2.7. Cables shall be installed in trunking and galvanised conduit and terminated at the Luminaire position in a 6A PCR (plug in ceiling rose) (3 or 4 pin for standard) as KLIK type or MK type or equal. Note, 5 and 7 pin DALI plug/socket arrangements must be approved through written agreement with the responsible engineer.

3. FINAL CONNECTIONS TO LUMINAIRES:

- 3.1. Where fluorescent fitting spines do not cover BESA box open blanking plates with grommets shall be installed.
- 3.2. All luminaires shall be earthed with earth leads.
- 3.3. Where luminaires are recessed into a false ceiling the conduit shall terminate adjacent to the fitting in a KLIK socket outlet with the final connection being carried out with a 3 core circular 1.5mm² flex. Any reduction in cross-sectional area must be approved (in writing) by the responsible engineer.
- 3.4. Where an emergency light is integrated into a luminaire the ceiling outlet shall have an appropriate number of pins and the high temperature LSOH cord shall have a sufficient number of cores.
- 3.5. Where luminaires are mounted on the surface of the ceiling or wall, the circuit wiring shall terminate in a PCR (klik) connector (or through a connector arrangement that facilitates similar protection against overheating and accommodation of mechanical support) in the conduit box to which the fitting is fixed and the final connection shall be made in 3 core circular 1.5mm² high temperature heat resistant cord meeting the acceptable DCA requirements.
- 3.6. Standard DCA Approved 70 degrees Thermoplastic cables insulated cables shall not in any circumstances be used for final connections to tungsten luminaires.
- 3.7. The contractor is required to ensure that all conduit outlets are sufficiently facilitated with a bonding provision. The minimum requirement is one connection per branch conduit with 2.5 mm² DCA Approved 70 degrees Thermoplastic cables (minimum) where a separate CPC for the circuit is utilised.

- 3.8. Luminaries in suspended ceilings shall be earthed by the appropriate core in the flexible cord.

4. SWITCHES:

- 4.1. Switches shall comply with the I.S.EN 60669 series, BS 3676 and IEC 669-1, and shall be suitable for use on inductive or resistive loads and rated for 10 amps minimum. They shall be single-pole one-way unless otherwise indicated or approved and where located adjacent to each other they shall be grouped in a multi-gang single enclosure and share a common switch-plate.
- 4.2. The rocker shall be double insulated and have a quick positive action. Brass terminals shall be pillar screw type with terminal screws to facilitate ease of connection including looping in and out of the terminal.
- 4.3. Ease of fixing and alignment shall be provided by an adjustable grid, which shall cover the box aperture and an elongated fixing lug to facilitate correct alignment. The large grid shall allow wiring to be connected without fixing the cover plate and in turn allow decorating work to be completed before the final fix. All units, except architrave assemblies shall fit boxes to BS 4662 with a minimum depth of 25mm. The switch grid shall be complete with a flying earth lead for connection to the box lug.
- 4.4. All boxes shall be of galvanised steel and provided with earth terminals with bonding link to cover-plate/switch grid. Cover plates shall be clearly and permanently labelled (e.g., Traffolyte) with the circuit reference. Multi-phase switch assemblies shall be complete with internal red phase warning labels clearly indicating '400 volts'.
- 4.5. Complete samples shall be submitted to the responsible Engineer for approval before any switches are placed on order. All samples shall be complete with boxes.
- 4.6. Ceiling switches (pull chords) shall be provided as indicated and shall be rated 15 amp one way or two way to BS 3676 and I.S.EN 60669 with 51 mm centres suitable for installation in small circular conduit boxes to BS 4568.
- 4.7. Cord operated switches shall comply with EN 61558 and be supplied with a 1.5 m white pull cord and insulated grip.
- 4.8. Switches shall be mounted in accordance with clause 530.7 of I.S. 10101 at 1100mm centre from the full floor level unless particular requirements dictate otherwise.

5. LUMINAIRES:

- 5.1. The Contractor shall provide for the supply and delivery to site of all luminaires specified under this Contract.
- 5.2. All details of individual luminaires are located in schedule.
- 5.3. All luminaires and ancillary equipment are to be installed as per manufacturers guidelines. Any deviation from this is only with the written consent of the responsible engineer.
- 5.4. Care is warranted for the adequate ventilation and support for luminaires and any associated ancillary device (drivers / transformers. Particularly in false ceilings.
- 5.5. Where modular suspended ceilings are used the final lighting arrangement is to confirmed with the responsible engineer once the ceiling grid is in place.
- 5.6. Before placing final orders, the Contractor shall obtain approval from the Architect for each type of luminaire intended for use and shall make due allowance for submission of samples to the Architect as required. A provisional sum is included in the summary of tender for the provision of sample luminaires and demonstration of luminaires.

6. EMERGENCY LIGHTING SYSTEM:

- 6.1. The Contractor shall include for the supply, wiring, erection, and connection of a complete emergency lighting installation as indicated on the drawings, including luminaires complete with lamps and external conversion units where required.
 - 6.1.1. The Contractor or Specialist Contractor for the installation, testing, commissioning and certifying of the Emergency Lighting System shall be registered to perform those duties under the Building Emergency Safety Systems (BESS) scheme, have successfully completed a nationally approved QQI Level 6 Course for those duties.
- 6.2. The emergency lighting installation shall be provided by means of emergency lighting luminaires, to provide a system of "escape lighting" complying with I.S. 3217 and IS EN 1838. The equipment shall comply with the attached emergency luminaire specification in Appendix 5.
- 6.3. The installation shall utilise non-maintained self-contained emergency luminaires and maintained self-contained exit sign luminaires, and luminaires shall be surface and semi-recessed.

- 6.4. Wiring to the self-contained luminaires shall be taken from the adjacent lighting circuit and a local means of isolating for each luminaire shall be provided by means of a 4 pin Klik type socket and plug (coloured Red) to provide a maintained supply to all charger units.
- 6.5. The permanent supply to the battery/charger units shall be derived from the same local circuit as the general lighting in line with IS 3217.
- 6.6. The self-contained luminaire based emergency lighting system shall incorporate a testing scheme as required by IS 3217 and in this project that shall be achieved by the existing Hochiki NEPTO emergency lighting system.
- 6.7. In areas with suspended plaster ceilings, it may be necessary in some situations to cable from the emergency luminaire to a location where there is an access point to the ceiling void and where there is a lighting junction box or local distribution boards.
- 6.8. On completion of the work of installation the emergency lighting system, the Contractor / Commissioning Engineer shall commission, test and certify the System. The Contractor shall provide to the Engineer an inspection and test certificate as specified in IS 3217 and I.S. EN 1838, duly completed.
- 6.9. The Engineers shall be given 1 weeks' notice of the commissioning and testing of the complete installation, so that they may witness the process.
- 6.10. EMERGENCY LUMINAIRES:
 - 6.10.1. The Contractor shall supply, erect and connect the luminaires complete with lamps, specified in the schedule attached to the rear of this Specification.
- 6.11. All emergency luminaires and exit signs shall be supplied complete with Compliance Certificates to EN 60598-2-22 for the particular luminaire.
- 6.12. All relevant aspects specified in the "General Luminaires" clause above shall apply to the emergency luminaires. Final connections to emergency luminaires shall be enclosed in conduit.
- 6.13. Local isolation of exit signs shall be afforded by means of a 4-pin 'Klik' outlets.

7. EXTERNAL LIGHTING:

- 7.1. The Contractor shall supply, install, test and commission a complete external lighting installation, as indicated on drawings and specified hereafter.
 - 7.1.1. External Lighting installations shall be in accordance with section 714 of I.S. 10101.
- 7.2. The luminaires shall be circuited, as indicated on drawings and shall be routed, using cable tray, trunking and conduit and ducting as required.
- 7.3. All outgoing circuits shall use 600/1000 volt grade SWA cables meeting the current DCA requirements when routed within a building sized as indicated on drawings.
- 7.4. Cables in trenches and pipe ducts shall be installed in accordance with the Appendix to this Specification.
- 7.5. Joints in cables installed underground shall not be accepted except where such joints are sanctioned by the responsible Engineer and shall be made in an approved manner, with approved jointing accessories, to the satisfaction of the Engineer, and by a qualified cable joiner.
- 7.6. Where underground pipework enters a building the radius of the pipe bend shall be of the 'slow' type not exceeding the minimum bending radius of the cable.
- 7.7. WALL MOUNTED LUMINAIRES
 - 7.7.1. Wall mounted luminaires shall be wired by means of 4 core PVC/SWA/PVC or XLPE/SWA/ PVC cable in sizes as detailed on the drawings.
 - 7.7.2. The cables shall be wired to a splitter box, adjacent to the luminaire, within the building on the loop-in loop-out basis.
 - 7.7.3. The Contractor shall wire from the splitter box to the lantern such that the wiring system is afforded both appropriate mechanical protection while also facilitating sufficient means to avoid condensation within any associated splitter boxes.
 - 7.7.4. The Contractor shall provide an earth lug in the splitter box solidly bonded to the single wire armouring of the incoming cable.
 - 7.7.5. One of the cores of the four-core cable to the lantern shall act as an earth lug in the splitter box.

APPENDIX 1

RECORD DOCUMENTATION

1. GENERAL:

- 1.1. The following specification covers the preparation and supply to the Engineer of a comprehensive Hardcopy and Digital Project Safety File (DPSF) incorporating the following:-
 - 1.1.1. Operating and maintenance manual(s).
 - 1.1.2. Record drawings.
 - 1.1.3. Testing, commissioning and proving reports.
- 1.2. Of the four sets, three complete sets of documentation shall be provided to the Client on practical completion and one complete set shall be supplied by the Contractor to the Project Safety Officer.
 - 1.2.1. The tenderer shall agree at an early stage with the client and engineer as to the form (Hardcopy or digital) of the O&M manual.
- 1.3. The documentation shall be written, assembled and completed in accordance with the requirements of EN 82079-1 : 2020, "Technical manuals", and BSRIA BG 79, "Handover Information and O&M Manuals".
- 1.4. The Contractor shall be required to demonstrate during the course of the works that adequate and accurate records are being maintained and that record documentation is being progressively compiled.
- 1.5. Where information is required from material or plant suppliers/manufacturers the Contractor shall request such details from the relevant company. The Contractor shall allow for any charges that may be required by manufacturers or suppliers for the provision of information and literature.
- 1.6. The Contractor shall issue a draft copy of the record documentation to the Engineer for approval 6 weeks before the planned practical completion of the project.
- 1.7. The final documentation shall be capable of being used without other supporting information.

2. PRESENTATION:

- 2.1. The manual(s) shall be presented in a format which allows for three levels of reader ability:-
 - 2.1.1. Non-technical (those who use or occupy the building).
 - 2.1.2. General technical (those responsible for managing the operation and maintenance of the building).
 - 2.1.3. Specialists (those who maintain the building).
- 2.2. The manual(s) shall be A4 size, hard bound, and shall comprise a loose leaf system.
- 2.3. Manual details, logos, addresses and other relevant information shall be provided on the front cover and on the spine if space permits.
- 2.4. An information sheet shall be provided at the front of the manual(s) listing the names and addresses of the principals (main contractor's engineers and mechanical and electrical sub-contractors) involved on the contract.
- 2.5. The manual(s) shall be arranged with an index and referencing system, with numbered card dividers between sections.
- 2.1. In respect to hard-copy submissions, the paper used in the final issue shall be good quality, white, 120 g/m², and the reproduction method shall be dry photocopy.
- 2.2. All documentation shall be written in English. The text of descriptive sections shall be kept concise while at the same time ensuring completeness.
- 2.3. Jargon shall be avoided. New terms shall be defined when first introduced. Abbreviations shall only be used if they have been defined or their meaning is clear from the text.
- 2.4. Illustrations, drawings and diagrams incorporated into the manual(s) shall be easily read in conjunction with the relevant text.
- 2.5. The instructions applicable to the project shall be highlighted by the Contractor on the initial copy for the Engineer's approval, and on all four final copies.

3. CONTENT AND LAYOUT:

- 3.1. The manual(s) shall follow the framework set out in BSRIA BG 79 and shall include purpose and planning information, technical documentation including record drawings, full operating instructions for each system, detailed maintenance instructions and schedules, emergency information, parts lists, modification instructions, disposal instructions, manufacturers' literature, together with procedures and results of all tests undertaken during the testing and commissioning process.

4. RECORD DRAWINGS:

- 4.1. The drawings shall be issued in CAD and PDF format A0 or A1 size and each drawing shall be clearly marked "record drawing".
- 4.2. Record drawings shall be executed by a competent draughtsman and shall contain sufficient detail to enable the Employer to maintain, dismantle, reassemble and adjust all parts of the works.
- 4.3. Lettering on drawings shall be to an approved lettering system and the title block shall be to the Engineer's approval.
- 4.4. The title block shall not contain any revision notes or references, nor shall the drawings contain any references to existing services or similar notes.
- 4.5. The drawings shall clearly show all systems, plant, terminal points such as luminaires, sockets, isolators, etc. and distribution, circuit orientation and references. All sizes of tray, trunking and their routes shall be indicated. All plant shall be clearly referenced and shall be readily identifiable.
- 4.6. The Contractor shall ensure that any services which are buried within the structure, or underground, are precisely located on the drawings, along with the precise positions of entry of services to the building, giving their depth and the locations of the relevant pits, etc.
- 4.7. The drawings shall incorporate all building changes which may have occurred during the course of the contract.
- 4.8. The Contractor shall provide the following for inclusion in the manual(s):-
 - 4.8.1. A schedule of record drawings, including those issued by manufacturers or suppliers during the course of the works, e.g. switchgear layout and control panel wiring diagrams.
 - 4.8.2. A complete set of drawings, in numerical order, reduced to A3 size and printed on good quality paper identical to that used for the remainder of the manual(s).

- 4.8.3. Any isometric or diagrammatic drawings.
- 4.8.4. Copies of distribution board identification charts.
- 4.9. The Contractor shall provide digital record drawings to the AutoCAD Release version requested by the Engineer / Client.
- 4.10. The Contractor shall provide one copy of each of the warning signs and safety charts, which shall be heat sealed or fixed in glazed hardwood frames, for installation in locations to be agreed on site.

5. COMPLETION CERTIFICATES:

- 5.1. The Contractor shall submit the following certificates when the installation is completed and include copies in the manual(s):-
 - 5.1.1. Safe electric certificate of entire installation.
 - 5.1.2. 4 part certificates for fire alarm and emergency lighting (Design, Installation, Commissioning and Handover).
 - 5.1.3. Lightning protection certificates (Design, Installation, Commissioning and Handover).
 - 5.1.4. Certificates from suppliers or manufacturers stating that equipment has been installed and commissioned satisfactorily and is operating in accordance with the design requirements.
 - 5.1.5. Safe electric sub-system certificates.
 - 5.1.6. All system testing and commissioning certificates and results.
 - 5.1.7. An IOU (incomplete, outstanding or unsatisfactory work) shall be attached to a certificate in the event of any work not required at hand-over stage, and a programme agreed for the completion of works.

APPENDIX 2

ELECTRICAL SUB-SYSTEM CERTIFICATION

In accordance with the Safety, Health & Welfare at Work (General Application) Regulations, 2007 – 2012 every new electrical installation and every major alteration or extension to an existing installation shall after completion be inspected and tested by a competent person in an approved manner, and a certificate of test shall be completed verifying that the relevant requirements of these Regulations have been complied with.

After the installation has been tested and found to comply, the contractor or other person responsible for the construction of the installation, or a person duly authorised to act on his behalf, must sign a statement to that effect. The statement must be in the form of an approved certificate. Certification in accordance with the requirements of CRU and Safe Electric will be deemed to meet this requirement. In addition to the certificate, the test record sheets containing the results of tests carried out must be retained. The certificate must be completed by an authorised person having adequate technical knowledge and experience.

In accordance with the above the proposed electrical installation specified herein shall be certified as having been installed, inspected and tested in full in accordance with the CRU and Safe electric rules pertaining to an electrical installation as prescribed by NSAI IS 10101 National Rules for Electrical Installations (5th Edition). In this respect ALL electrical works relating to the project shall be tested and certified.

Where a new or amended ESB service is required, the completed works shall be required to have a Safe Electric completion certificate.

For electrical sub-systems, which are defined as being “any system that will be connected to the low voltage network of any installation, with the exception of portable appliances that are designed for such use” and examples of which are:

- Lift installations
- Electrical works not requiring an ESB connection
- A/C or ventilation systems
- UPS
- Datacoms works
- Specialist electrical equipment installations
- Standby generation
- Fire protection systems
- Etc.

Such sub-system contractors shall ensure that:

- a All electrical works are carried out by a qualified electrician or by an apprentice electrician under the supervision of a qualified electrician.

- b A sub-systems certificate in the form attached must be completed by the sub-systems contractor for each sub-system within his contract, where applicable. This will include sub-system works carried out by another party but forming part of the contractor's scope of work or contract. An example of this would be a fit-out electrical contractor who has a number of specialist systems suppliers, e.g., fire suppression, A/C, audio visual, under his fit-out contract but where he is linking to an existing main or sub main switchboard that has been installed and has had an Safe Electric completion certificate certified by others.
- c In addition to receiving one or more sub-systems certificates from the specialist suppliers working under his contract, the main sub-systems contractor must also complete a sub-systems certificate in respect of his work.
- d Prior to any electrical contractor making a power supply available to a sub-systems contractor, he must obtain a completed sub-systems certificate from that sub-systems contractor.

The contractor supplying a sub-systems certificate must be a registered Electrical Contractor.

APPENDIX 3

LOW VOLTAGE SWITCHGEAR

1. GENERAL:

- 1.1. This specification outlines the general requirements for all low voltage switchgear to be provided within the terms of the contract.
- 1.2. The contractor shall include for the supply, manufacture, delivery to site, positioning, testing and commissioning of the entire switchgear installation as part of the contract.
- 1.3. The object of this specification is to define the standards to which the switchgear and motor control panels are to be designed, manufactured and tested and to identify the particular requirements and operating conditions for which the switchgear and motor control panels are intended.
- 1.4. Nothing in this specification shall relieve the manufacturer/contractor from his responsibility to provide a safe and durable assembly(ies).
- 1.5. This document does not fully specify all aspects of the panel - it is intended as a guide only.
- 1.6. The responsibility for providing a complete, safe and satisfactory control panel rests with the manufacturers.
- 1.7. From this point on all switchgear and motor control panels shall be referred to as switchgear.
- 1.8. To be read in conjunction with Part 3.1 of the specification.

2. STANDARDS:

- 2.1. All switchgear shall comply with the requirements set out in current editions of IS EN 60439-1 and draft IEC 61439 / 1-6. Also any codes of practice issued by the IS 10101:2020 relating to switchgear assemblies. In addition, the switchgear shall comply with the particular requirements of the Electricity Supply Authority and with the particular requirements of this Specification.

The following standards and IS 10101:2020 rules and requirements shall also apply:

BS EN 60439/IEC 60439 Low-voltage switchgear and control gear assemblies

BS EN 60439-2 Particular Requirements for Busbar Trunking Systems (Busducts)

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

BS EN 60044, IEC 60044 Instrument transformers.

BS EN 60947 Low Voltage Switchgear and Control gear.

IS 10101:2020 with all associated Amendments.

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

IEC 60227 PVC insulated cables of rated voltage up to and including 450V/750V.

IEC 60051 Direct acting indicating analogue electrical measuring instruments and their accessories.

BS EN 61000 Electromagnetic compatibility (EMC).

ISO 3864 Graphical symbols -- Safety colours and safety signs.

BS EN 60255 Measuring relays and protection equipment.

BS EN 61558 Safety of power transformers, power supplies, reactors and similar products.

BS EN 60617/IEC 60617 Graphical Symbols for Diagrams.

EN 50005 Specification for Low Voltage Switchgear and Control Gear for Industrial Use.

In addition, the following standards shall be adhered to:-

IS EN 60269	- Fuses.
IS EN 60947-2	- MCCB's/ACB's.
IS EN 60898 or CEE 19	- MCB's.
IS EN 60947-4-1/2	- Contactors.
IS EN 60947-4	- Overload Relays.
IS EN 60947-5	- PB's Lamps etc.
IEC 60185 or BS 7626	- CT's.
IS EN 60051	- Instruments.
BS 142	- Restricted Earth Fault Relays
IS EN 61009 & EN 61008	- Differential current operated earth leakage circuit breakers.
89/393/EEC	- Machinery Directive
73/23/EEC	- The Low Voltage Directive
89/336/EEC	- Electro Magnetic Compatibility Directive

3. LV SWITCHGEAR :

- 3.1. The main switchboard shall be manufactured in accordance with this switchgear specification and the approved specialist supplier's drawings. They shall be inspected by the Contractor and the Engineer at the specialist supplier's workshop before delivery to site.
 - 3.1.1. Where necessary to suit site access, board locations and safe handling the boards shall be constructed and delivered to site in sections within ACBs, MCCBs etc racked out to reduce the weight of the overall section.
 - 3.1.2. All switchboards shall be manufactured to fit the space provided. 1,200mm shall be provided in front of all switchgear to facilitate future maintenance and operation.
 - 3.1.3. The contractor shall include for the supply and installation of a unistrut support framework, where the boards are intended for mounting on solid walls.

- 3.1.4. The contractor shall include for the supply and installation of trunking headers over/under/beside the boards suitably sized to ensure a non-constricted delivery and distribution of individual circuits/cores to terminals.
- 3.2. The equipment to be furnished to these specifications shall in all respects be of the highest quality, of the latest advances in technology, and of modern engineering design and workmanship.
- 3.3. All electrical switchgear, breakers etc from LV distribution to LV motor control centres shall be from the one manufacturer throughout.
- All Air circuit breakers, moulded case circuit breakers and miniature circuit breakers shall be manufactured by ABB, Schneider Electric, or equal.
 - All metal work shall be of CUBIC, Logstup manufacturer or equal utilising a certified cubic system builder.
 - All motor control equipment shall be manufactured by Schneider Electrical, ABB or equal and shall be installed by an approved partner.
- 3.4. All Main Switchboards, Sub-Main Distribution Boards and Motor Control Centres shall be Form 4 type A.
- 3.5. All Final distribution boards and composite MCB distribution sections shall be Form 2B and shall utilise Merlin Gerin Isobar EVO4 pan assemblies.
- 3.6. All fixtures and connections shall be tightened/torqued on site before final inspection. All units shall be securely fixed before any cables are connected.
- 3.7. Before being commissioned all units shall be cleaned and damaged paintwork repaired and identification labels fixed.
- 3.8. Buyer shall have the right to witness tests and shall be notified at least 5 working days in advance of any tests to allow a representative to be present.
- 3.9. Buyer shall assign an inspector to inspect the equipment as well as to expedite during the Fabrication and manufacturing of the switchgear. Standard factory tests shall be performed on the assemblies.
- 3.10. Copies of certified test reports on tests performed shall be furnished by the Manufacturer.
- 3.11. Where necessary to suit site access, board locations and safe handling the boards shall be constructed and delivered to site in sections.
- 3.12. The Panel Manufacturer shall ensure that full discrimination exists between the Incoming & Outgoing Breakers.
- 3.13. The equipment shall be designed for ease of field erection and field maintenance. It shall be warranted to perform to these specifications with a minimum of field maintenance for the class of equipment specified.

- 3.14. The offloading and positioning will be by the nominated Electrical Contractor, however the delivery to site and final assembly/ commissioning will be carried out by the specialist panel manufacturer.
- 3.15. As part of the tender return, the supplier shall submit a fully dimensioned elevation and plan drawing of the main switchboard layout.
- 3.16. The Contractor shall include for on-site work by the specialist supplier of the switchgear, mounting and assembly of the modular compartments, modifications to switchgear terminals, gland plates, etc. to accommodate specified cable sizes. This attendance shall also include for on-site testing of the performance of the board.
- 3.17. The supply of interconnections, fuses and traffolyte designation labels is deemed to be included as part of the respective switchboards.
- 3.18. It shall be the contractors responsibility to ensure sufficient glanding space is available for all cabling as the need for header trunking supplied by the electrical contractor may be a requisite.
- 3.19. All switchboards and LV motor control panels shall have a rubber mat fitted to the front of board/panel, the mat shall be 12mm thick (approx.), 0.9m wide and extending to the full length of the board/panel front (and rear if necessary). The mat shall conform to DIN53481.
- 3.20. All switchboards shall be se suitable for expansion on both ends.

4. CIRCUIT INDEX CHARTS:

- 4.1. Circuit index charts contained in clear plastic waterproof containers shall be adhesive-fixed inside every distribution board.
- 4.2. The index shall be completed in waterproof ink and shall fully identify and describe each circuit protected.
- 4.3. The index shall also identify the neutral connections for the outgoing circuits which must be connected in sequence to correspond with the phase conductor of the circuit.
- 4.4. The Contractor shall include for the supply and fixing of all circuit index charts and plastic envelopes.
- 4.5. The electrical contractor shall supply and install a framed A1 "AS BUILT" LV schematic or single line adjacent to the relevant switchboard.
- 4.6. It is the electrical contractors responsibility to update the existing site wide SLD which will be "Free issued" to the contractor in AUTOCAD format. This should be completed prior to practical completion.
- 4.7. The numbering system and Switchboard designation shall be agreed with the client prior to FAT.

MECHANICAL DESIGN:

4.8. Basic Construction

- 4.8.1. The switchgear enclosure shall be of fixed pattern, suitable for connection to a 400Volt 50 Hz TP & N supply system.
- 4.8.2. The equipment shall be capable of withstanding the short circuit conditions of the system, as specified on the attached Single Line drawings.
- 4.8.3. The phase sequence and colouring of the supply shall be L1, L2, L3 brown, black, and grey respectively. All power conductors and connections shall be arranged to follow this sequence, reading from left to right or top to bottom, when observed from the front of the control panel.
- 4.8.4. Neutral conductors shall be coloured blue.
- 4.8.5. Earth conductors shall be coloured green and yellow.

4.9. Enclosures

- 4.9.1. The Switchgear is intended for indoor use unless otherwise specified. . It shall be free standing of heavy gauge sheet steel (1.2mm min.) bolted frame construction (frame min. 2mm steel) totally enclosed, degree of protection IP54 (Min).The metalwork shall be of modular design as supplied by CUBIC, Logstap or equal.
- 4.9.2. A rigid steel floor plinth, of minimum height 100mm, shall be provided on each switchboard. The switchgear shall be constructed in such a manner that it may be divided into sections for transportation and for installation on site.
- 4.9.3. It shall be the electrical contractors responsibility to ensure that sufficient supports to take the weight of the switchboard where trenches are provided.

4.10. Compartmentation

- 4.10.1. All busbars and other conductors, which are common to, more than one circuit shall be run in separate compartments from incoming and outgoing conductors and components. Covers to busbar chambers shall be fitted with screw-fixed trafolyte labels, coloured yellow and engraved with 6mm high letters as follows: "DANGER 400 VOLT BUSBARS". All such covers that give access to live components shall be fixed to the switchgear framework by means of screws .Similar fixing screws, removable by special key may also be used. Each incoming and outgoing circuit shall be completely enclosed in a separate compartment fitted with a hinged door. The unhinged side of the compartment door shall be fixed to the frame by means of lockable handles. Door structures and hinging shall be so designed as to ensure that doors do not deflect, drop or distort due to their own weight and/or the weight of apparatus mounted on the door.

- 4.10.2. All compartments shall be formed using rigidly framed sheet steel dividing panels capable of containing the effects of the most severe fault within the compartment.
- 4.10.3. Each compartment shall contain busbars, cables, wiring and components of its own circuit only.
- 4.10.4. Mechanical door safety interlock or complete internal shrouding shall be provided in all circuit breaker compartments.
- 4.10.5. Where cross interlocking is required between circuit breakers, it shall be carried out using approved type interlocks.
- 4.10.6. Each door shall be fitted with a neoprene or similar approved non-ageing gasket to prevent ingress of dust or moisture. Aluminium Non ferrous gland plates shall be used where single core cables are utilised.
- 4.10.7. Any doors or covers that are to have cut outs for example door mounted instruments are to be painted prior to instrument installation.
- 4.11. Door fasteners shall be double bit lock type. The minimum number of fasteners provided shall be as follows:

Door less than 400 mm high	- 1 fastener.
Doors greater than 400 mm high	- 2 fasteners.
Doors greater than 1,200 mm	- 1 lock with a minimum of 3 locking points
- 4.12. Cable compartments shall be sized to allow installation of the cables shown on the single line diagram(s) and shall be suitable for top or bottom entry of cables as required. As a minimum cable compartments shall incorporate cable tray for the dressing of field cables. Minimum bending radii of cables shall be a principal factor in determining cable compartment dimensions.
- 4.13. The minimum width for a front access cable compartments for a single apparatus stack shall be 400 mm. The minimum width where the cable compartment is common to two apparatus stacks shall be 600mm.
- 4.14. Armoured cables may be glanded at the entry point to cable compartments (Form 4 type 2) or within cable compartments adjacent to each functional unit (Form 2B), depending on the form of switchgear.
- 4.15. Under no circumstances shall the switchboards support the weight of the field cabling. The contractor shall provide adequate support remote from the switchboard.
- 4.16. Adequate means for bracing of cables within cable compartments shall be provided.
- 4.17. It shall be the switchgear manufacturers responsibility to ensure that gland plates are selected on the basis of cable type and cable sizes.

- 4.18. It is the electrical contractors responsibility to ensure that the correct gland types are used to suit both the cabling and the IP protection of the switchboard. All holes/opes shall be suitably plugged.
- 4.19. Particular care shall be exercised in the design of cable entry and glanding points to ensure that additional cables can be easily installed if required in the future.
- 4.20. The completed assembly shall be fully sealed to prevent the entry of vermin.
- 4.21. Removable plates shall be provided for access to busbars for switchgear extension purposes.

5. BUSBARS:

- 5.1. All Busbars must be front accessible to allow thermal imaging to take place.
- 5.2. The current rating of the copper busbars must be such that :-
 - The busbar must carry the full load current at a maximum temperature of 30 degrees over ambient throughout. A full temperature rise calculation is to be submitted prior to approval.
 - The busbar system shall be fully type tested and utilise all proprietary connections.
 - To eliminate Eddy Currents within the board, consideration shall be given for the use of non-magnetic (stainless steel/Aluminium) busbar holders.
 - The Busbar shall be FULLY rated throughout the switchboard.
 - Neutral Busbar shall be the same size as the phase busbar.
- 5.3. Busbars shall be of hard drawn rectangular section solid copper fully rated for the current specified.
- 5.4. Busbars shall be rigidly supported by non -combustible insulating material.
- 5.5. Connections between main and/or secondary busbars and each functional unit shall be by means of copper busbars as specified above for all ratings in excess of 100 A.
- 5.6. Where ratings of less than 100A are specified for functional units, connection between busbars and apparatus terminals may be made in PVC insulated copper tails suitably rated and braced to withstand thermal effects under normal conditions and mechanical stresses under faulty conditions. The current rating of the interconnecting tails shall be equal to or greater than the current rating of the functional unit concerned.

- 5.7. Compression type cable lugs must be used at both ends of interconnecting tails.
- 5.8. Main and secondary busbar systems shall incorporate the neutral busbar which shall be contained in the main and secondary busbar compartments. Neutral terminals shall be provided in each functional unit alongside the phase terminals.
- 5.9. Neutral busbars shall not be installed in cable compartments.
- 5.10. Main and secondary earth busbars shall be not less than 25 mm x 5 mm solid hard drawn copper and secondary earth busbars shall be provided in all cable compartments for direct bonding of cable armouring.
- 5.11. The main earth bar shall be continuous along the full length of the switchgear assembly as shall secondary earth busbars be continuous through the full height of cable compartments.
- 5.12. All doors shall be earthed by means of an earth cable.
- 5.13. Proprietary Busbar jointing systems (other than drilled and bolted fixings) shall be selected to provide a strong, simple joint which ensures the maximum surface contact between bars while minimising the risk of improper installation.
- 5.14. All joints shall be shown to be properly installed and secured following commissioning on site.

6. NEUTRALISING:

- 6.1. Where indicated in the drawings/schedules, the switchgear manufacturer shall provide neutralising facilities as detailed below.
- 6.2. The neutralising link shall be fully accessible.
- 6.3. The neutralising link shall be solidly bolted to the main earthing busbar and labelled accordingly.

7. FUNCTIONAL UNITS:

- 7.1. WITHDRAWABLE UNITS shall:
 - 7.1.1. Effectively isolate incoming and outgoing power terminals in the test position.
 - 7.1.2. Be provided with mechanical safety catches which must be operated to allow complete withdrawal from the switchgear assembly.
 - 7.1.3. Be provided with mechanical level or other type facility to assist with withdrawal and inspection of withdrawable units to ensure both correct alignment of terminals and correct insertion force.

- 7.1.4. Be provided with switch actuator interlocks to ensure that units cannot be withdrawn on load.
- 7.1.5. Utilise multipin plugs and sockets for connection of auxiliary and/or control circuit wiring.
- 7.1.6. In the test position, disconnected and removed position, result in a degree of protection at the unit and switchgear assembly in relation to contact with live parts of IP20 or better.
- 7.1.7. Allow access to all components without the need to remove cable compartment covers etc.
- 7.2. **FIXED UNITS:**
 - 7.2.1. The outgoing terminals of outgoing functional units of fixed pattern design shall be wholly within the functional unit sub-compartment. Adequate space to accommodate crimped type cable lugs shall be provided.
 - 7.2.2. Live side terminals of functional outgoing units shall be shrouded to IP20 or better.
 - 7.2.3. The switching device actuator shall be interlocked with the switch unit to ensure that the functional unit is in the OFF position before the door can be opened. The interlocking arrangement shall be of the defeatable type with use of a tool.

8. EQUIPMENT AND COMPONENTS:

- 8.1. **SWITCHES:**
 - 8.1.1. All mechanical switching devices shall be of the load break type.
 - 8.1.2. All mechanical switches shall have an AC23 utilization category and shall be rated for intermittent duty.
 - 8.1.3. The short circuit capacity shall be as stated for the complete switchgear assembly in the attached details sheets.
 - 8.1.4. All mechanical switching devices shall be "switches" as defined in IEC specifications unless otherwise stated.
 - 8.1.5. Local isolators, where specified, shall be as defined above for switches.
 - 8.1.6. Local isolators, where used to isolate motors, shall be capable of breaking the locked rotor current safely. These local isolators shall also contain auxiliary switches to be incorporated within its associated control circuit.
- 8.2. **FUSES:**
 - 8.2.1. This project shall be a fuseless installation. Fuses will only be accepted for control circuits.
- 8.3. **MOULDED CASE CIRCUIT BREAKERS (M.C.C.B.'s):**
 - 8.3.1. All Moulded Case Circuit Breakers up to 630A shall be plug in type. All Moulded Case Circuit Breakers greater than 630A shall be withdrawable.

- 8.3.2. All Moulded Case Circuit Breakers shall be rated as shown on drawings:-
- 8.3.3. All Moulded case circuit breakers shall be manufactured by Merlin Gerin, or equal. All MCCB's shall be adjustable incorporating micrologic electronic trip units with a minimum thermal setting of 0.4 times the MCCB rating. All MCCB's greater than or equal to 800A shall have its own individual outgoing cable cubicle with sufficient space for the termination of field cables.
- 8.3.4. Each circuit breaker / feeder shall be mounted in a separate cubicle and shall be equipped with an extended handle, protruding through, and interlocked with, the cubicle door.
- 8.3.5. All components in a compartment shall be de-energised when the isolating switch for that compartment is in the "OFF" position with the exception of:
- Incoming live terminals of the functional device
 - 2. Terminals/fuses of control or alarm supplies - if any. (These should be fully shrouded and provide IP 20 protection as a minimum).
- 8.3.6. All MCCB's shall be adjustable incorporating micrologic electronic trip units with a minimum thermal setting of 0.4 times the MCCB rating.
- 8.3.7. All MCCBs shall be rated to the perspective symmetrical short circuit value as shown on the drawings. Switchgear manufacturer shall take peak short circuit rating into consideration.
- 8.3.8. All MCCB's shall be fully integrated into the SCADA system to provide real time monitoring via "Intelligent Electronic Devices" (IED's) to provide IED Parameterization (configuration/Parameter upload from IED & Change of individual parameters or parameters sets). The IED's shall come complete as part of the MCB's been provided as part of the contract. Refer to appendix 7 for further details on the SCADA system.
- 8.3.9. MCCB's shall, in addition to the ON and OFF position, have an intermediate "tripped" position or trip indicator flag and the mechanism shall be of the "trip free" type.
- 8.3.10. Provision shall be provided on the outgoing side of the Moulded Case Circuit Breaker for the anticipated cable size. This shall include but is not limited to specific proprietary lugs/connecting terminals to enable disconnection.
- 8.4. AIR CIRCUIT BREAKERS (ACB's):
- 8.4.1. All circuit breakers and power feeder switches shall be of the fault make and break pattern, i.e. capable of making the maximum fault current at any time, without damage to the equipment or the operator.
- 8.4.2. Air Circuit breakers shall comply with BS4752: Part 1 and shall be of the withdrawable pattern, trip free type, complete with stored energy closing and tripping facilities. The stored energy shall be supplied from a hand charged spring/operating handle or equal alternative device.
- 8.4.3. Circuit breakers shall be suitable for continuous operation and shall be

capable of handling the fault currents specified.

- 8.4.4. Circuit breakers shall be complete with arcing contacts, arc suppression shields and all equipment, such as C.T.'s, relays, control fuses, shunt trip coil, terminal shrouds etc. All contacts shall be removable for ease of maintenance.
- 8.4.5. All Air Circuit Breakers shall be the new generation Micrologic electronic type units with LSI Protection . All Air Circuit Breakers including busbar couplers identified shall be 3-pole.
- 8.4.6. All Air circuit breakers shall be rated as shown on drawings.
- 8.4.7. All ACB's shall incorporate an external 24 volt DC supply to independently power the electronic trip unit. Where mechanical interlocking is proposed, a detailed matrix of operation shall be submitted prior to fabrication for review.
- 8.4.8. Air circuit breakers shall be fitted with shunt trip mechanisms and shall have 2 No. N/O and 2 No. N/C auxiliary contacts.
- 8.4.9. Facility shall be provided as standard for padlocking the ACB in the OFF position.
- 8.4.10. Air Circuit Breakers shall incorporate LSI protection (Long term, short term, & instantaneous). All ACB's shall incorporate an external 24 volt DC supply to independently power the electronic trip unit.
- 1.1.1. All ACB's shall be fully integrated into the SCADA system to provide real time monitoring via "Intelligent Electronic Devices" (IED's) to provide IED Parameterization (configuration/Parameter upload from IED & Change of individual parameters or parameters sets). The IED's shall come complete as part of the ACB's been provided as part of the contract. Refer to appendix 7 for further details on the SCADA system.
- 8.4.11. All ACB's shall be rated to the perspective symmetrical short circuit value as shown on the drawings. Switchgear manufacturer shall take peak short circuit rating into consideration.

8.4.12. ACBs shall come with trip units that can be set to provide an IDMT response that can be coordinated with similar upstream MV Circuit Breaker Protection Relays.

8.5. SURGE PROTECTION:

- 8.5.1. A type 1 and 2 class 1 and 2 transient voltage surge suppressor to IEC 61643 will be required for all main electrical boards and all switchgear and instrument panels that supply external circuits. The manufacturer shall be DEHN.

8.6. MINIATURE CIRCUIT BREAKERS (MCB's):

- 8.6.1. MCB's shall have ON and OFF positions and have a tripped indicator flag.
- 8.6.2. The MCB mechanism shall be designed to provide quick break on manual, tripped operation and be current limiting.
- 8.6.3. MCB's shall be correctly selected either for the prospective fault level specified in the schedule(s) of particulars, or for the fault level provided by the

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back-up protective devices.

8.7. RESIDUAL CURRENT DEVICES (RCD's):

- 8.7.1. RCD's shall be of the differential current operated type "A" device.
- 8.7.2. RCD's shall be in compliance with the requirements of the IS 10101:2020 in relation to tripping time unless otherwise stated and shall have a maximum differential current to trip value of 30 mA.
- 8.7.3. The mechanism of RCD's shall have direct fault simulation test facilities.

8.8. CONTACTORS:

- 8.8.1. Contactors shall be rated for intermittent duty -Class 3 and shall have utilisation characteristic AC3 except in the case of "braking" or "plugging" requirements where AC4 shall be used.
- 8.8.2. Contactors shall have, in addition to the auxiliary contacts for the control functions required, 2 No. sets of N/O and N/C auxiliary contacts.

8.9. OVERLOAD RELAYS:

- 8.9.1. All overload relays controlling three phase motors shall provide single phase protection under all load conditions.
- 8.9.2. Overload relays shall be provided with a minimum of 1 set of additional change-over contacts and shall be manually reset from panel mounted push buttons.

8.10. AUXILIARY RELAYS:

- 8.10.1. Auxiliary relays shall be of the 11 pin plug-in type with din. rail mounting base and "coil energised" indicator lamp and manual contact operator.

8.11. CONTROL SWITCHES AND INDICATOR LAMPS:

- 8.11.1. All control switches, push buttons and indicators shall be standard 22 mm dia. type protected to IP54 or better. Terminals on all control devices shall be shrouded to IP20 or better. [LED type may be put forward but they must be visible from the side.]
- 8.11.2. Fixing of control devices into the front face of panels shall be by means of 22 mm nut complete with washers. Openings in panel faces for control devices shall be keyed to ensure that devices cannot rotate or loosen in service.
- 8.11.3. Signal lamp units shall be of the transformer type and lenses shall be of translucent self-coloured material. Lamps shall be a minimum of 2 watts rating.
- 8.11.4. Push button control units with the exception of emergency stop units shall be provided with guard rings.
- 8.11.5. All push button, selector switch and indicator units shall be provided with legend plates bearing the appropriate legends.
- 8.11.6. Colours of push-buttons and indicator lights shall be in accordance with EN 60073.

8.12. CURRENT TRANSFORMERS (CT's):

- 8.12.1. CT's for protection purposes shall have accuracy class designation 5P20.
- 8.12.2. Instrument CT's shall have accuracy class 1 designation or better and the instrument security factor shall be compatible with the instruments selected but shall not exceed $F_s = 5$.
- 8.12.3. The rated output of current transformers chosen shall be correctly matched to the connected burden. If necessary, additional burden must be connected in the secondary circuit to achieve this end.
- 8.12.4. The rated secondary current of CT's shall be 5A.
- 8.12.5. Secondary wiring from CT's shall be in 4 sq. mm. 450/750 grade PVC1 cables.
- 8.12.6. Clearly identified CT short circuiting terminals shall be provided for all instrumentation CT's.
- 8.12.7. CTs for field mounted instruments shall be 1A secondary type unless otherwise indicated.

8.13. CONTROL TRANSFORMERS:

- 8.13.1. Where indicated on the drawings or where more than five electro-magnetic coils are incorporated in one assembly, control transformers shall be provided.
- 8.13.2. Control transformers shall be 400 Volt primary, 230 Volt secondary isolating type with earthed screen between windings. One side of the secondary winding shall be solidly connected to earth.
- 8.13.3. They shall be continuously rated for full load conditions and shall have a voltage regulation of not more than 4%.
- 8.13.4. Each phase of the primary feed shall be protected by means of HRC fuses or a double pole MCB rated as shown on the drawings. The unearthed side of the secondary winding shall be protected by means of a single pole MCB having thermal overload and instantaneous electro-magnetic tripping characteristics suitably rated to afford close excess current protection of the unit.
- 8.13.5. Control transformers shall be rated to serve equipment provided within the enclosure together with associated external loads e.g. solenoid valves. 25% spare capacity shall be provided in all cases.
- 8.13.6. Where indicated, duplicate control transformers shall be provided for duty/standby operation.
- 8.13.7. Each control transformer shall be equipped with a failure indication lamp and changeover shall be by manual switching.
- 8.13.8. Changeover shall be effected by means of a six pole double throw rotary changeover switch which shall effectively isolate primary and secondary circuits of the transformer in standby mode.

8.14. ANALOGUE INSTRUMENTS/METERS:

- 8.14.1. Instrumentation shall be supplied as specified on the drawings and shall be of the flush panel mounted type.
- 8.14.2. All instantaneous type meters shall be of the moving coil pattern with FSD = 90° (-0 to + 90°). Meters utilising a time component shall be of the induction type.
- 8.14.3. Scale graduations shall be chosen to give clearest readings under normal load conditions.
- 8.14.4. Meters utilising a current function may be direct reading up to a 50A but shall utilise CT's for currents greater than 50A.
- 8.14.5. Meters shall have accuracy classifications equal to or better than their CT's but shall not be less than Class 1.
- 8.14.6. The range of all meters with the exception of frequency and power factor shall be so chosen as to indicate values up to 120% of rated maximum values. Frequency meters shall have range = rated frequency $\pm$ 10%. Power factor meters shall have range - .5 to + .5.
- 8.14.7. Meters shall be installed at approximately 1500 mm above ffl.
- 8.15. DIGITAL INSTRUMENTS/METERS:
 - 8.15.1. Digital instruments/meters shall be provided to indicate voltage (P-N) and (P-P), current, kWhr, power, power factor and reactive power. They shall also be used to transfer information to a BMS system and be complete with RS232 and RS422 interfaces for any or all of the above quantities.
 - 8.15.2. The display shall be an LCD display with controls to allow whichever quantity is to be displayed.
 - 8.15.3. The meter shall be suitable for compiling energy cost and trends.
- 8.16. TERMINALS FOR CONTROL AND INSTRUMENT WIRING:
 - 8.16.1. All terminals for control and instrument wiring shall be of the DIN rail mounted type.
 - 8.16.2. Terminals shall have facilities for cross connections and identification and complete terminal assemblies shall afford protection against direct contact equal to IP20 or better.
 - 8.16.3. Screw type clamp terminals shall be used and shall be so designed that the terminal screws and clamping yokes are of hardened steel. Current carrying links shall be of copper or brass. The cables to be terminated shall be brought into firm contact with the grooved current carrying link by means of a stirrup type clamping arrangement.
 - 8.16.4. Terminals of the type where clamping screws act directly on cables shall not be used.
 - 8.16.5. Terminal identification markers shall be of white thermoplastic with markings in black. Markers shall clip into moulded slots on each terminal.

9. TERMINALS FOR POWER CIRCUIT WIRING: (FORM 2 & 3 ASSEMBLIES ONLY):

- 9.1. Terminals for power circuit wiring shall be generally as specified for control circuit wiring with the exception that for cables of cross sectional area 10 sq. mm or larger fully shrouded stud type terminals shall be used.
- 9.2. All cables in excess of 70 sq. mm cross sectional area shall be terminated directly at the terminals of the device concerned.
- 9.3. Adequate space between glanding position of cables and terminal rails shall be provided to ensure completed installation is in compliance with IS 10101:2020 regulations in relation to minimum bending radii of cables. To this end the minimum distance between glanding plate and terminal rail outgoing side face shall be twice the minimum bending radius of the largest incoming cable core plus 25 mm subject to a minimum dimension of 75 mm.

10. FINAL CIRCUIT DISTRIBUTION BOARDS:

- 10.1. Final circuit distribution boards shall be provided as indicated.
- 10.2. Final circuit distribution board assemblies shall be adequately rated for the fault level specified and where installed as a composite part of a larger assembly, shall be adequately protected against faults beyond their capacity.
- 10.3. This shall be effected by means of fault limiting MCCB's or HRC fuses suitably selected in terms of rated current and maximum "let through" current.
- 10.4. Final circuit distribution boards shall be laid out such that external circuit connections to individual circuit protective devices can be made with ease and safety while the board is live.
- 10.5. If the switchgear manufacturer is in any doubt as to whether his proposed arrangement meets the above requirement, or where specifically requested to do so, all final circuit protective devices shall be wired to labelled terminals as specified.
- 10.6. Under no circumstances will the installation of fully enclosed, domestic type final circuit distribution boards in switchboard cubicles be permitted.

11. INTERLOCKING:

- 11.1. Mechanical interlocking, where specified, shall be of the key transfer type or direct acting interlocking linkages.
- 11.2. Key transfer interlocking systems shall be non -defeatable and the keying mechanism shall be non -masterable.
- 11.3. Where direct acting linkages, key transfer or electrical interlocking are employed to avoid paralleling of consumer generated supply and ESB supply the system shall be so designed as to provide bilateral break before make operations.

12. SPARE WAYS AND SPARE SPACE:

- 12.1. Unless stated otherwise, 25% spare capacity shall be included in all assemblies.
- 12.2. Spare ways shall be fully fitted out complete with functional units and all equipment necessary to bring the spare way into service. The quantity and rating of the spare ways shall be as indicated on drawings or as scheduled.
- 12.3. For planning purposes the cable sizes for spare ways shall be assumed to be equal to the largest size cable indicated for functional units of the same rating in the assembly or the next larger size cable to that cable size required to carry the full current of the functional unit concerned whichever is larger.
- 12.4. Where spare space for additional functional units is specified, it should be understood that space only for future installation of apparatus is required. However, modification to existing functional units, busbars, cables etc. should not be required. Where Form3 assemblies with spare space are specified the relevant sub sections shall be fitted with doors, partitions and busbars tap-off units as required, or in the case of withdrawable equipment all incoming and outgoing socket connections and guide rails shall be fitted. Sub-sections designated spare space shall have live connections fully shrouded to IP20.

13. LABELLING AND IDENTIFICATION:

- 13.1. Labelling and identification of switchgear shall be in accordance with Section 9 of IS 10101:2020 Code of Practice and as specified below.
- 13.2. Covers to busbar chambers shall be fitted with screw-fixed trafolyte labels, coloured yellow and engraved with 6mm high letters as follows: "DANGER 400 VOLT BUSBARS". All such covers that give access to live components shall be fixed to the switchgear framework by means of screws. Similar fixing screws, removable by special key may also be used. Each incoming and outgoing circuit shall be completely enclosed in a separate compartment fitted with a hinged door. The unhinged side of the compartment door shall be fixed to the frame by means of lockable handles.
- 13.3. All labels shall be of engraved sandwich type material screw fixed using a minimum of 2 No. nylon or steel machine screws.
- 13.4. Identification labels shall be in 5 mm high black characters on white background.
- 13.5. Danger labels shall be fitted on each vertical section and shall have 10 mm characters on red background and shall state the voltage present.
- 13.6. Where not mounted in individual cubicles, all apparatus shall be clearly labelled within the assembly. The labelling shall correspond exactly with equipment identification labels used in the manufacturer's drawings.

14. INTERNAL CONTROL AND INSTRUMENT WIRING:

- 14.1. Internal control and instrument wiring shall be 1.5 sq. mm 450/750 volt grade flexible panel wiring unless otherwise specified. Internal control and instrument wiring shall be enclosed in slotted PVC cable trunking with clip-on lid.
- 14.2. Where serving door mounted equipment, cables shall be protected by means of flexible PVC tubing rigidly fixed at both ends and fitted at the hinged side of the door.
- 14.3. Control and instrumentation wiring shall be terminated by means of insulated crimped ferrules.
- 14.4. Every control and instrumentation connection wire shall be identified at each termination using numbered interlocking plastic ferrules. Wire numbers shall correspond exactly with those used in the manufacturer's schematic diagrams.

15. TESTING AND INSPECTION:

- 15.1. The switchgear manufacturer shall allow for inspection and performance of routine tests in the presence of the Engineer at the works. Routine tests to be undertaken are as listed in any parts of IS EN 60439 and any code of practice issued by the IS 10101:2020.
- 15.2. Prior to attendance by the Engineer for the purposes of inspection and witnessing of tests, the switchgear manufacturers shall perform the required tests and carry out a detailed inspection to ensure that all faults have been eliminated.
- 15.3. The switchgear manufacturer shall notify the Engineer when the switchgear is completed and ready for inspection and witnessing of tests.

16. INFORMATION REQUIRED FROM SWITCHGEAR MANUFACTURER:

16.1. INFORMATION REQUIRED ON PLACEMENT OF ORDER:

16.1.1. The following information shall be provided within 10 days of receipt of order.

16.1.1.1. Two copies of detailed general arrangement, single line and control wiring drawings. These drawings shall identify all components by manufacturer and type. Operating characteristics of all protective devices shall be submitted. The switchgear manufacturer shall submit full fault level analysis to the Engineer with the drawings for comment.

16.2. INFORMATION REQUIRED ON COMPLETION:

16.2.1. The following shall be provided on completion of satisfactory tests in accordance with Appendix 1.

16.2.1.1. Copies of "as-built" general arrangement, single line and control wiring drawings.

16.2.1.2. 4 copies of completed signed and witnessed test certificates.

16.2.1.3. 4 copies of list of spares and accessories supplied.

16.2.1.4. 4 copies of short circuit test certificates from an independent test house if applicable or if custom built assembly.

16.2.1.5. 4 copies of design calculations verifying short circuit strength of assembly.

16.2.1.6. Any information required in this Specification and related documents and standards.

LOW VOLTAGE SWITCHGEAR

SCHEDULE OF SPARES AND ACCESSORIES

The following spares and accessories shall be supplied with each switchgear assembly where applicable:-

1. 2 No. Cubicle access keys.
2. 2 No. Fuse withdrawal tools where N.H. style cartridge fuses are used.
3. 3 No. Spare fuses of each rating and type used in the assembly.
4. 12 No. Spare bolts used for fixing cubicle side and back cladding.
5. 250 cl. tin of touch-up paint.
6. 6 No. Label fixing screws.
7. 2 No. Lenses of each colour and type for indicator lamps.

**LOW VOLTAGE SWITCHGEAR
SCHEDULE OF PARTICULARS
NEW MAIN LV SWITCHBOARD OLB1**

Item	Required/Available	Proposed by Manufacturer
Busbar current rating:	Refer to drawings.	
Supply characteristics:	400V 50Hz TP & N	
Prospective symmetrical short circuit current)	100KA	
)		
)		
Peak asymmetrical short circuit current)		
)		
Rated power frequency withstand current)		
Fault withstand classification:	Form 4A	
Protection against indirect contact:	Class 2	
External design:	Multi cubicle	
Service conditions:	Standard indoor	
Degree of protection:	IP 42	
Type of mounting:	Free standing on own structural steel support system as identified in Part 3.1 of this specification.	
Component mounting:	Withdrawable	
Cable entry/exit:	Bottom	
Fire Suppression:	Pressurised Novec 1230 System. Linear detection tubing installed throughout the panels and cableways	
Operating access:	Front only	
Working access:	Front only	
Finished colour:	Manufacturer's standard colour with internal Busbar Indication.	
Surge Protection:	Type 1 & 2.	

17. TYPICAL EQUIPMENT TO BE INCORPORATED INTO MAIN SWITCHBOARDS FOR STANDBY GENERATOR OPERATION

GENERAL:

- 17.1. The following equipment is to be incorporated into OLB1 associated with standby generator operation by the LV Electrical Contractor:
- 17.2. The LV Electrical Contractor shall be responsible for the design of the entire control strategy for each of the 2 No. future standby generator systems in accordance with the proposed control philosophy document issued as part of the tender documents.
- 17.3. The LV Electrical Contractor shall supply and install all equipment to ensure the system operates in accordance with the existing and proposed control philosophy.
- 17.4. The LV Electrical Contractor shall prepare a detailed and comprehensive control document including drawings as part of the contract.
- 17.5. All components to be installed within the main switchboards associated with the standby generator operation shall be a CoMAp product. This is to ensure full integration of the new standby generators into the existing hospital site wide standby generator network.
- 17.6. All cabling to be integrated into the main switchboard for controlling the standby generator systems shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks.
- 17.7. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist as part of the contract. The LV Electrical Contractor shall also be responsible for the supply and installation of all external cabling and for issuing out schematic drawings clearly identifying all wiring requirements.
- 17.8. The primary trip shall be via the sub-station Transformer ACB. The secondary G10 trips shall be via the transformer MV breakers.
- 17.9. **EQUIPMENT/WIRING TO BE INSTALLED WITHIN THE SWITCHBOARD TO FACILITATE GENERATOR OPERATION**

GENERATOR 1

- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

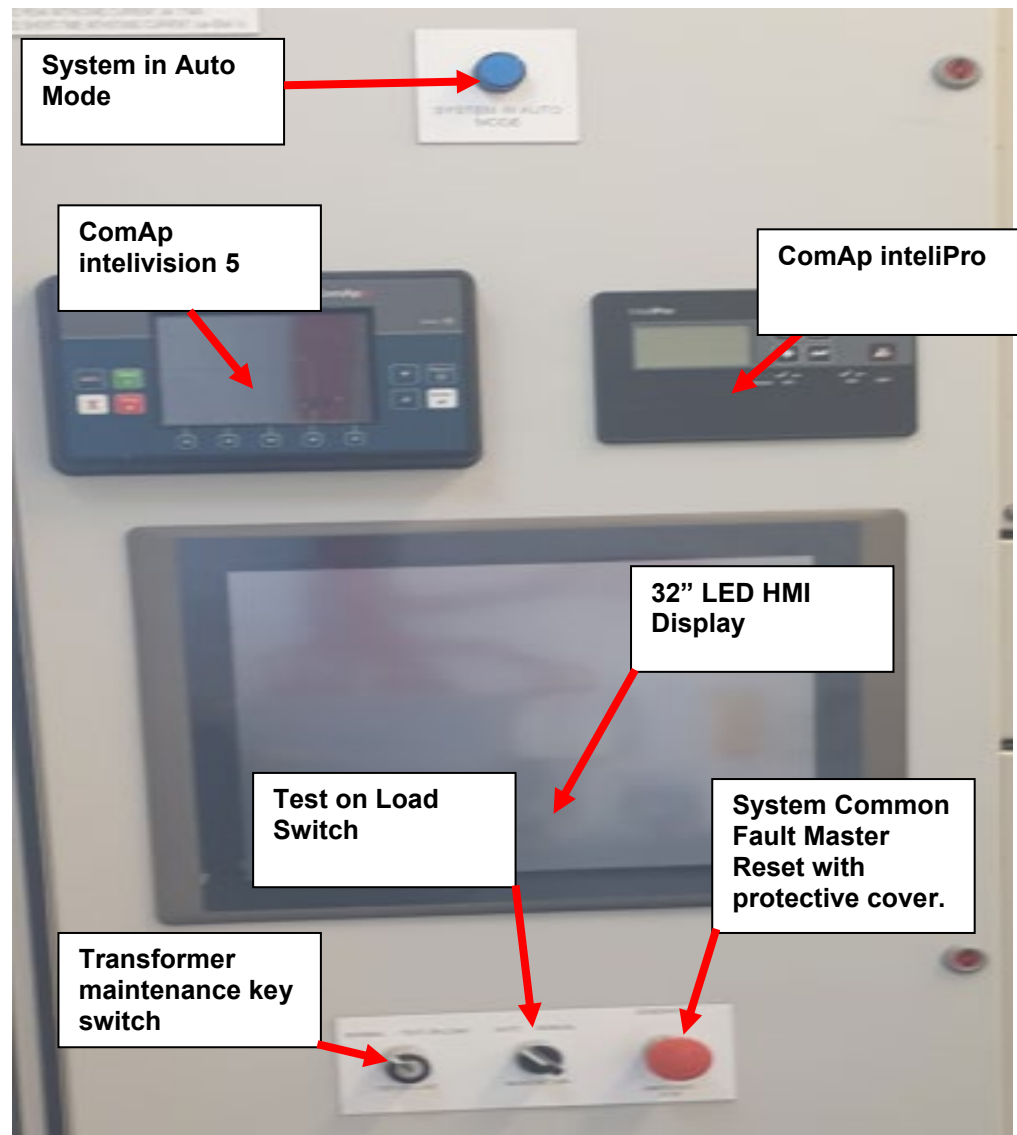
GENERATOR 1

- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

MAINS

- ComAp Inteli Pro Controllers (G10 Controller).
- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.
- 32" LED HMI display shall be installed in the main new switchboard to associated with the Generator control philosophy system.

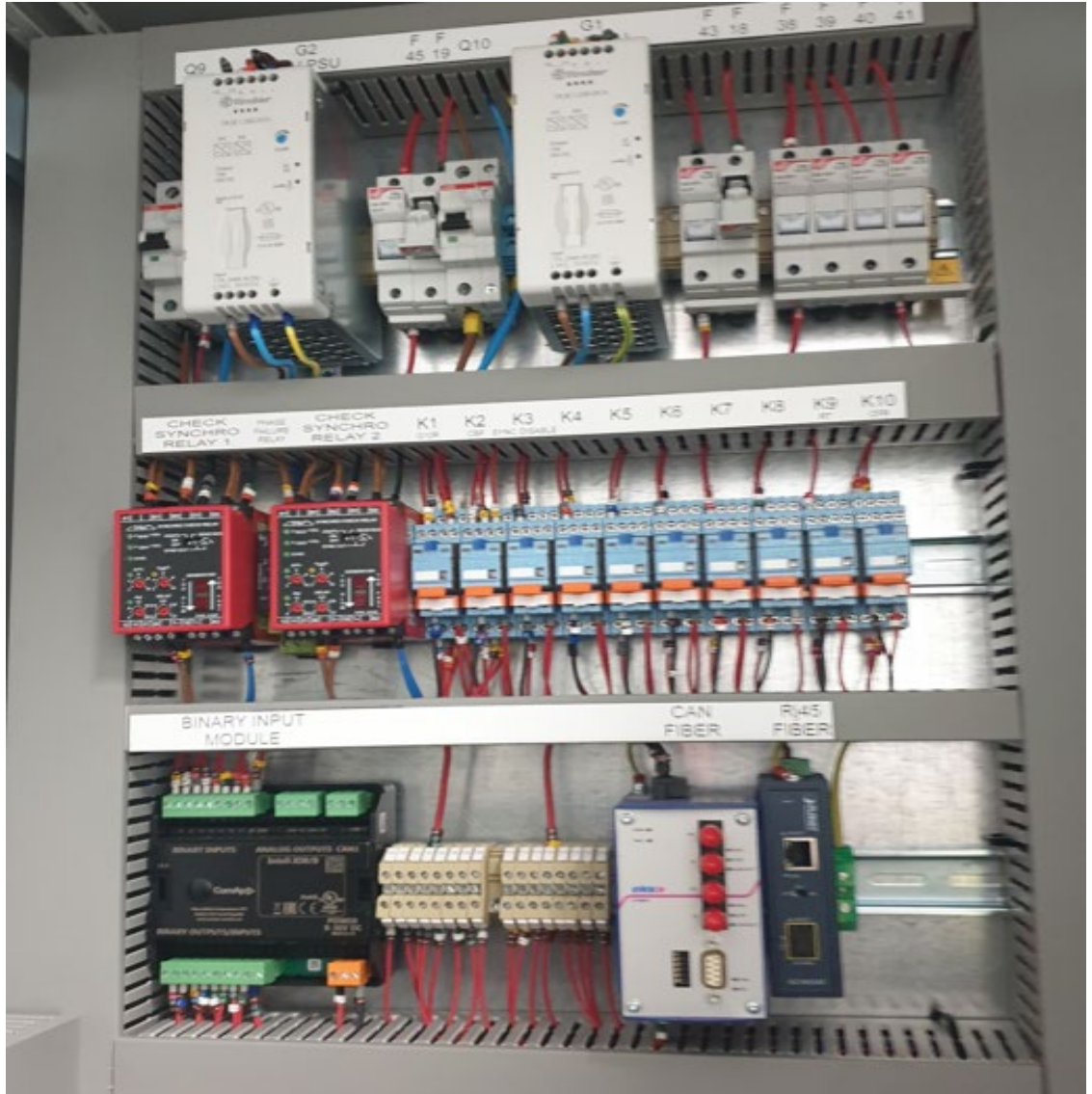
Note: All components must be a ComAp system to allow full integration into the existing ComAp standby generator hospital network.



TYPICAL MAIN SWITCHBOARD PANEL FACE.

The Off-Loading Switchboard OLB1 shall incorporate the following:

- **Test on Load Switch:** To allow standby generator system to automatically synchronise with the sub-station supply and operate in short term paralleling. When switch returned to normal position the standby generator system will again automatically synchronise with the sub-station supply and automatically return the sub-station to the normal supply.
- **Transformer Maintenance:** To allow the transformer to be maintained without loss of power to sub-station.
- **System Common Fault Master Reset** push button with protective cover.



TYPICAL NEW MAIN SWITCHBOARD COMPONENTS ARRANGMENT

ComAp
The heart of smart control



Datasheet



Order code: INTELIPRO

Protection Relay for Parallel Applications

Product description

InteliPro is highly flexible protection relay for grid connected applications like generator sets, renewable energy sources, cogeneration, micro turbines, etc.

Key functions

- > Voltage, frequency and current based protections for on-grid distributed power generation

Key features

- > True RMS measurement
- > 3-phase voltage and current measurement
- > Automatic fault reset with adjustable time delay
- > Two stage protection settings
- > Optional functions for extended protection
- > Free assignment of 8 binary inputs, 9 binary outputs and 3 analog inputs
- > Full and easy configuration through the front panel or LiteEdit PC software
- > Expandable extensions and communication modules
- > Remote access
- > 3 level password protection
- > Event history log

Application overview



ComAp
The heart of smart control

**InteliGen NTC
BaseBox**



Order code: IG-NTC-BB
Gen-set Controller

Datasheet

Product description

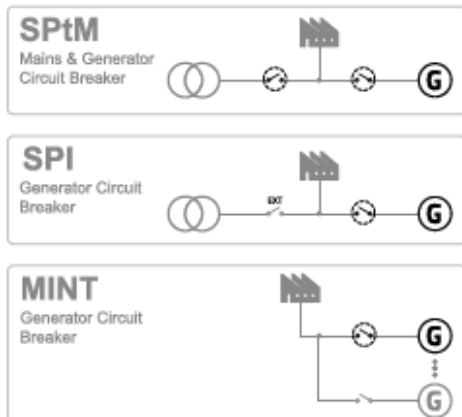
- ▶ Comprehensive paralleling gen-set controller
- ▶ Parallel operation up to 32 gen-sets
- ▶ High level control for complex systems
- ▶ CHP and gas engine controller

Key features

- ▶ Load sharing and VAR sharing via CAN
- ▶ Virtual shared inputs and outputs via CAN
- ▶ Support of wide range of applications
- ▶ Single or multiple gen-sets in parallel to mains operation with automatic back up function, multiple island operation
- ▶ Advanced power management function
- ▶ Customizable load control in parallel to mains
- ▶ Wide range of ECU support
- ▶ Extended communication capabilities
 - Built-in web server
 - Full Modbus slave support
 - GPS and AirGate support and more
- ▶ Highly configurable
 - Timers, Internal PLC, Force values and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Active e-mail messaging and SMS

- ▶ Extensive built-in protection functions
 - Standard protections
 - User configurable protection
- ▶ Extendable with ComAp's extension modules

Application overview



ComAp
The heart of smart control

**InteliMains
NTCBaseBox**



Order code: IM-NTC-BB

Comprehensive switchgear controller

Datasheet

Product description

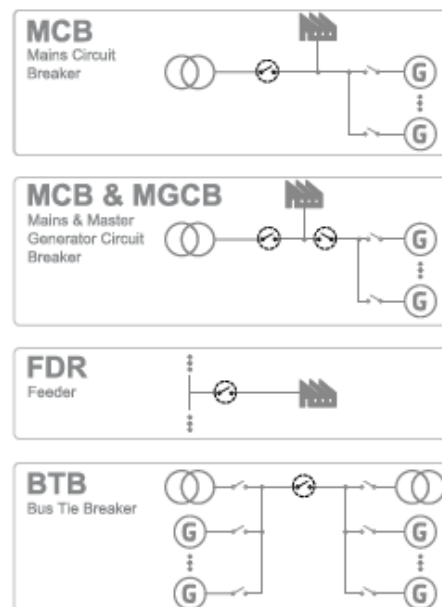
- ▶ Comprehensive switchgear controller
- ▶ Built-in control for up to 32 logic groups divided by Bus Tie Breakers
- ▶ High level control for complex systems

Key features

- ▶ Built-in breaker control
- ▶ Genset group synchronization, Loadsharing and Varsharing via CAN2
- ▶ Customizable load control in parallel to mains
- ▶ Extended communication capabilities
 - Built-in web server
 - Airgate support and more
- ▶ Highly configurable
 - Timers, internal PLC, Force value and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Monitoring and configuration with ComAp's PC tools
- ▶ Extensive built-in protection functions
 - Undervoltage, overvoltage
 - Underfrequency, overfrequency and more
- ▶ Full Modbus slave support (RS232)
- ▶ Extendable with ComAp's extension modules

- ▶ True RMS (TRMS) is used with Voltage, Current and Power measurement

Application overview



18. GENERAL:

- 18.1. The following is a general description of the control philosophy required for OLB1.
- 18.2. The contractor shall prepare a detailed and comprehensive control document including drawings for the hospital.
- 18.3. The control philosophy applies to the FUTURE standby generator, the proposed new standby generator and integration into the MV/LV switchgear.
- 18.4. The afore mentioned control and protection equipment shall be incorporated into OLB1 by the switchgear specialist, to allow the FUTURE generator to synchronise with network.
- 18.5. The contractor shall supply and install a control system to provide the control of the standby generators as identified herein.
- 18.6. All internal wiring from the controllers to ACB, relays etc shall be provided by the switchgear specialist as part of the contract.
- 18.7. All external cabling to be integrated into the main switchboard for controlling the system shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist.
- 18.8. All Main ACBs should have a 24V DC shunt opening coil and 230V shunt opening coil powered from the generator voltage and wired to the G10 controls.
- 18.9. Mains LV ACBs should have closing coils powered from mains.
- 18.10. Generator ACBs should have 230V UVR opening coil powered from the generator voltage and wired to two sets of terminals (one for generator controls and one for G10 controls).
- 18.11. Generator ACBs should have a 230V closing coil powered from the generator voltage.
- 18.12. All ACBs should have charging motors powered from the respective voltage.
- 18.13. 3 N/O & 2 N/C auxiliaries shall be installed on the mains ACBs and generator ACBs complete with tripped and racked out status.
- 18.14. Mains current 6 wires should be available from 5A measurement current transformers for the generator controllers.
- 18.15. Mains voltage should be available 3PH and N from 6A fuses.
- 18.16. 4 wire 400V 32A supply is required for generator auxiliary supplies.

- 18.17. Check synch /dead Bus relays required across each mains ACB, Generator ACBs and Coupler ACB.
- 18.18. Secondary G10 trips shall be via the transformer MV breakers MV1 and MV2. MV breakers shall come complete with relays/contactors etc for this function.

19. GENERAL CONTROL STRATEGY

Index of “Normal” Scenarios

- Normal operation: ESB supply healthy
- Mains /ESB Fails
- Mains return
- Brief Mains/ESB failure
- Test Off load
- Transfer to Generator / Test on Load
- G10 operation short term parallel
- Generator maintenance – safe isolation method.

Index of “Abnormal” or failure Scenarios (What if?) (the below scenarios are not included at this time but these and other what ifs! Can be implemented)

- ESB supplying load, mains fail. Mains ACB fails to open.
- Main ESB Circuit breaker trips on overload, system in Automatic, Generator not running
- Main ESB Circuit breaker opens OR is opened, system in Automatic, Generators not running
- Generator failure.
- MV Generator failures during a power failure.
- Site supplied by generator, Mains return sequence and Mains ACB Fails to close.
- Site supplied by generators, Mains return sequence - Gen breaker fails to open
- Site supplied by generators, LOSS OF COMMS FROM MASTER SYSTEM.
- Site supplied by Mains, LOSS OF COMMS FROM MASTER SYSTEM.

“Normal” Scenarios

Normal operation: ESB supply healthy

External Events	CONTROL SYSTEM ACTIONS
Mains Healthy and supporting site load	• Mains circuit breaker MCB closed • LV generator 1 not running • LV generator 2 not running • System in Auto • Generator circuit breaker (GCB) open • Site load supported from ESB supply • Mains MV healthy

Mains /ESB Fails

External Events	CONTROL SYSTEM ACTIONS
Mains failure: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • When synchronised the generator ACB's close. • Standby power LV generators 1 & 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generators 1 & 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy
External Events	CONTROL SYSTEM ACTIONS
Mains Manual Return if running on generators: Keyswitch in Manual position ComAp controller detects ESB within set-point limits	• When ESB Mains is available again system waits for 15 minutes before any action • LED indicates ESB Healthy • Key-switch in Position 1 "Manual return" • Operator chooses to restore Mains by turning Key-switch into position 0 "Auto return" • Main ACB closes under synchronous conditions i.e. (no blip return to mains/MV gens) • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cool down cycle. • Site load supported from ESB supply • Mains MV healthy

Brief Local Mains Failure

External Events	CONTROL SYSTEM ACTIONS
Mains failure: ComAp controller detects ESB set-point limits	• System waits for 5 seconds to see if ESB supply restores • If mains ESB returns under 5 seconds, then no action • Mains circuit breaker MCB does Not Open • System in Normal Operation

Test Off load for Service checks

External Events	CONTROL SYSTEM ACTIONS
Operator to change Genset controller from Automatic mode into Manual mode	• The operator will push the mode button from Auto to Manual • The operator will push the gen start pushbutton • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • Operator can note down generator parameters and carry out generator running checks • Note: NO Interruption to supply
Operator to change Genset controller from Manual mode to Automatic mode	• The Operator will push the gen stop pushbutton • The generator will go into cooldown and stop after a few minutes • If the Operator wants a sudden stop just press the gen stop pushbutton and the cooldown cycle will cancel and the generator will stop straight away • System reverts back to "Normal" • Operator to return generator controller from manual to automatic mode • Note: NO Interruption to supply

Transfer to Generator / Test on Load

External Events	CONTROL SYSTEM ACTIONS
Key switch : Position 1	• The operator will select key switch to position 1 for “Test on load” • After time period generator starts • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • LV generators 1 & 2 synchronises with mains supply and closes the generator ACB’s • Generator ramps up on power and takes up the OLB2 site load • OLB2 LV ACB Opens • Standby power now powering OLB2 load • Note: No Interruption to supply
Key switch : Position 0	• The operator will select key-switch to position 0 for “Normal operation” • Test on load condition cancels • SUB3 LV MCB closes under synchronous conditions i.e. (no blip return to mains) • Site Supported on ESB Mains supply • Generator ramps down and GCB • Generator cools down and stops after a few minutes • System reverts back to “Normal”

G10 Protection – short term parallel

External Events	CONTROL SYSTEM ACTIONS
Generator in parallel with mains for short duration. Mains disturbance causes G10 protection to operate.	- G10 protection is “active” during parallel connection only - G10 protection operates (Trip condition) LV ACB is opened by G10 panel, site load supported from Generator - Generator continues to run on load until G10 fault is reset NOTE: if OLB2 LV ACB fails to Open on G10 fault then G10 control system will Open SUB3 10kv breaker as a secondary trip (per ESB G10 regulations). Manual restore required.
Recovery procedure: G10 manually reset at G10 panel Key switch for manual/auto return to mains to be in the AUTO position	- Operator will select “KS1” from “Test on load” position 2 back to “normal position” 0 - Test on load condition cancels - LV MCB closes under synchronous conditions i.e. (no blip return to mains/MV gens) - Site Supported on ESB Mains/MV gens supply - Generator ramps down and Opens ACB - Generator cools down and stops after a few minutes - System reverts back to “Normal”

Generator maintenance – safe isolation method.

External Events	CONTROL SYSTEM ACTIONS
Generator Maintenance Generator Controller – Pushbuttons Position 0 OFF	- Press the Estop on the generator control panel - This will render the entire system control unavailable for operation - Manually Open Set mounted circuit breaker - When works are complete return system back into automatic by reversing the above procedure - Ensure system is back in Automatic and No alarms

“Abnormal” Scenarios

ESB supplying load, mains fail. ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
ACB fails to Open	OLB2 Generator will not close ACB in this situation and bring up a breaker fail to operate alarms Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker MCB trips on overload, system in Automatic, Generator not running.

External Events	CONTROL SYSTEM ACTIONS
ACB Trips Open	Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker ACB opens OR is opened, system in Automatic, Generators not running.

External Events	CONTROL SYSTEM ACTIONS
Mains ACB Opens OR is Opened	If Mains ACB breaker opens for NO reason that System is aware of then generator control system will reclose the Mains ACB. If Operator wants to Open Mains ACB then he must put generator control system into Manual mode

Mains /ESB Fails, Generator Fails.

External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 1 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 2 run up to stable speed and voltage. • Generator 2 ACB close. • Standby power LV generator 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 2 shall back off, and the mains supply will take up the load. • Generator 2 ACB's open. • Generators 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer
External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 2 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 run up to stable speed and voltage. • Generator 1 ACB close. • Standby power LV generator 1 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 1 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 shall back off, and the mains supply will take up the load. • Generator 1 ACB's open. • Generators 1 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer

Site supplied by generator, Mains return sequence and ACB Fails to close.

External Events	CONTROL SYSTEM ACTIONS
ACB Fails to Close	Maintenance engineers to investigate issue and repair. Generator control system will stay running on Generator until MCB is successfully Closed by control system

Site supplied by generators, Mains return sequence - Gen breaker ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
GCB Fails to Open	Maintenance engineers to investigate issue and repair. If ACB fails to Open after a three attempts generator will shut down and generator set mounted breaker should be opened so fault can be identified and rectified.

VOLT frees available to Others

Modbus connection is available from the generator Comap controller.

Volt free contacts are available from the generator up to a maximum of 4 without the need to add an expansion card to the generator control system.

Volt free contacts are available directly from the generator bulk fuel tank for tank level monitoring and bund leak.

These volt free signals are available to go to local BMS outstation.

VOLTFREE	Type	Comment
Gen running	DO	Signal closed = Generator running
Gen fault	DO	Signal closed = Generator fault
Genset NOT in Auto	DO	Signal open = Genset NOT in Auto
Fuel tank level low	DO	Signal closed = Fuel low
Fuel tank reorder level	DO	Signal closed = Fuel reorder
Fuel tank bund leak	DO	Signal closed = Bund leak
Modbus connection		Generator to Customer BMS

Engine Controller Configuration – generator controller.

Engine Inputs	CONTROL Function
• Emergency Stop • Oil Pressure • Water Temperature • Generator Circuit Breaker Status • Radiator Level • Over speed	Normally fail safe emergency stop circuit Digital Engine Low Oil Pressure Switch Digital Engine High Water Temperature Switch Status of the synchronising breaker; open and closed Digital input for Water Level (If available) Over speed
Engine outputs	CONTROL Function
• Fuel Solenoid • Electronic Governor • Starter Motor • Battery Charger On / Off control • Engine Heater On / Off control	Output to open the engine fuel for starting Power source for Speed controller, same configuration as Fuel solenoid Starter motor with adjustable RPM disconnect Disconnect battery charger on engine start / crank Disconnect Engine Heaters on engine start / crank
Engine Analogue Inputs	CONTROL Function
• Oil Pressure • Water Temperature • Engine Speed RPM • Generator Voltage • Generator Current	Engine mechanical protection; Low Oil Pressure Alarm & Shutdown Engine Mechanical protection; High Engine Water Temperature Alarm and Shutdown Engine speed derived from flywheel teeth Generator Bus Voltage reference; Voltage after generator synchronising breaker Generator Current Measurement
Engine Analogue Outputs	CONTROL Function
• Not required	

APPENDIX 4

LUMINAIRES

1. GENERAL

- 1.1. The specified luminaires must be utilised unless prior (written) agreement with the responsible engineer has been secured.
- 1.2. The party that is proposing a change to the specified luminaires shall do so at entirely their own cost.
- 1.3. The pre-approval process is outlined below (Section 2).
- 1.4. **Notwithstanding the criteria detailed in Section 2, Varming Consulting Engineers Ltd. is under no obligation to agree to any proposed change(s).**

2. PRE-APPROVAL PROCESS

- 2.1. Luminaires and equipment offered shall comply with all relevant Standards and Codes of Practice insofar as they apply.
- 2.2. Luminaires shall be supplied complete with lamps.
- 2.3. The general criteria associated with a change to the specified luminaires shall comprise of the following considerations.
 - 2.3.1. Luminaire data sheets
 - Conformance certificates from manufacturer within Europe or via an independent test-house (for a non-European jurisdiction)
 - Lamp efficacy
 - Luminaire power factor
 - Life span
 - Warranty on fittings
 - IP rating
 - IK rating (mechanical impact)
 - Luminaire suitability for the environment in which it will be installed
 - All (luminaire control) drivers shall be independently tested and shall display the ENEC European Safety Mark.

- Electrical Supply arrangements (including earthing, class I and class II (and class III where relevant))
 - Lamp colour
 - Colour rendering
 - Luminaire reflector/diffuser arrangements
 - Luminaire mounting arrangement (incorporating removable covers for maintenance where required)
- 2.3.2. Lighting design file that meets the design specification as provided by Varming Consulting Engineers Ltd. which include specifics concerning the following on the stated working plane.
- Power consumption (W/m²)
 - Illuminance (average, minimum and maximum)
 - Glare
 - Uniformity
 - Maintenance factors
 - D.L.O.R / U.L.O.R values
- 2.3.3. Lamps/luminaire availability (within the project timeline)
- 2.4. All (luminaire control) drivers shall be independently tested and shall display the ENEC European Safety Mark.
- 2.5. Contractor to confirm the ceiling type to be installed on the project prior to approval.
- 2.6. Contractor provide a working sample for review by Architect & Engineer prior to approval.

3. COMPLIANCE WITH STANDARDS:

3.1. GENERAL:

- 3.1.1. The luminaires and equipment offered shall comply with all relevant Irish and British Standards and Codes of Practice and in particular with the following insofar as they apply.

3.2. LUMINAIRES:

EN 13032-1	Light and lighting. Measurement and presentation of photometric data of lamps and luminaires. Measurement and file format
EN 13032-2	Light and Lighting- Measurement and Presentation of Photometric Data of Lamps and Luminaires- Part 2: Presentation of Data for Indoor and Outdoor Work Places
EN 60601-2-41	Medical electrical equipment - Part 2-41: Particular requirements for the basic safety and essential performance of surgical luminaires and luminaires for diagnosis
EN 60529	Degrees of Protection Provided by Enclosures (IP code)
EN 60598	Luminaires - Part 1: General requirements and tests
EN 60598-2-1	Fixed general purpose luminaires
EN 60598-2-3	Luminaires for road and street lighting
EN 60598-2-5	Floodlights
EN 60598-2-11	Aquarium luminaires
EN 60598-2-13	Ground recessed luminaires
EN 60598-2-18	Luminaires for swimming pools and similar applications
EN 60598-2-19	Air-handling luminaires (safety requirements)
EN 60598-2-21	Rope lights
EN 60598-2-22	Luminaires for emergency lighting
EN 60598-2-23	Extra low voltage lighting systems for filament lamps
EN 60598-2-24	Luminaires with limited surface temperatures
EN 60570	Electrical supply track systems for luminaires
EN 60598-2-25	Luminaires for use in clinical areas of hospitals and health care buildings
EN 60838-2-2	Miscellaneous lampholders - Part 2-2: Particular requirements - Connectors for LED-modules
EN 62031	LED modules for general lighting - Safety specifications
EN 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
EN 62471	Photo biological safety of lamps and lamp systems
EN 62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specifications
EN 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50 V - Performance requirements
EN 62717	LED modules for general lighting - Performance requirements
EN 62722-1	Luminaires Performance- Part 1: General Requirements
EN 62722-2-1	Luminaire performance - Part 2-1: Particular requirements for LED luminaires

3.3. CONTROL UNITS, OTHER AUXILIARIES AND ACCESSORIES:

All drivers shall be independently tested and shall display the ENEC European Safety Mark.

EN 61000-3-2	Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
EN 61000-3-3	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
EN 61347-1	Lamp controlgear - Part 1: General and safety requirements
EN 61347-2-13	Lamp controlgear - Part 2-13: Particular requirements for d.c. or a.c. supplied electronic controlgear for LED modules
EN 62384	DC or AC supplied electronic control gear for LED modules - Performance requirements
EN 61547	Equipment for general lighting purposes - EMC immunity requirements
EN 62386-101	Digital addressable lighting interface - Part 101: General requirements - System components
EN 62386-102	Digital addressable lighting interface - Part 102: General requirements – Control gear
EN 62386-207	Digital addressable lighting interface - Part 207: Particular requirements for control gear - LED modules (device type 6)

3.4. MISCELLANEOUS:

EN 55015	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
2006/42/EC	Machinery directive (Standard updated)
2014/35/EU	Low voltage directive (Standard updated)
2014/30/EU	Electromagnetic compatibility directive (Standard updated)
2002/95/EC	EC Directives on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

4. ELECTRICITY:

- 4.1. Unless otherwise indicated, all luminaires shall be suitable for use with a 1-phase 2-wire 230 volt 50 Hz earthed neutral system. The luminaires shall be designed to operate at all voltages encountered due to the fluctuations in nominal supply voltage, as stated by the Electricity Supply Board (+6 -10%).

5. ANCILLARY EQUIPMENT AND LAMPS:

- 5.1. Heat-resisting type lampholders shall be used with enclosed type luminaires, regardless of the lamp cap position, i.e. cap-up or cap-down.
- 5.2. Lampholders incorporated in weatherproof luminaires shall be of porcelain or brass.
- 5.3. Luminaires shall be supplied complete with lamps.
- 5.4. All internal wiring shall be carried out in "high temperature" flexible cables insulated with butyl silicone rubber (BS 6007) with copper conductors. The colour code shall be in accordance with ETCI National Rules.
- 5.5. Lampholders for use with tubular fluorescent lamps shall be gripping type with skirt covering lamp cap and protecting earth clip, complying with IS EN 60061.
- 5.6. Tubular fluorescent lamps shall be "Warm White" type to BS EN 60081, tungsten filament lamps shall be coiled coil type complying with BS EN 60064.

6. LUMINAIRES - ALL TYPES:

- 6.1. All luminaires shall have an ingress protection (IP) rating as dictated in the lighting schedule and shall be tested in accordance with the standards outlined in this section.
- 6.2. All luminaires shall have an protection provided against external mechanical impacts (IK) rating as dictated in the lighting schedule and shall be tested in accordance with the standards outlined in this section.
- 6.3. All luminaires shall have a lamp lumen per circuit watt (LL/CW) as dictated in the lighting schedule, typical values as follows;
 - 6.3.1. 110 LL/CW minimum for toilets ,circulation areas, etc.
 - 6.3.2. 130 LL/CW minimum for offices ,administration areas, etc.
- 6.4. All luminaires shall have a unified glare rating (UGR) as dictated in the lighting schedule, typical values as follows;
 - 6.4.1. Technical drawing/paper based work UGR <16.
 - 6.4.2. Reading, writing, training, meetings, computer-based work UGR <19.
 - 6.4.3. Craft and light industries UGR <22.

- 6.4.4. Heavy industry UGR <25.
- 6.4.5. Railway platforms, foyers UGR <28.
- 6.5. All luminaires shall comply with relevant safety and environmental standards outlined in this section.
- 6.6. All luminaires and the associated control gear (i.e. the driver) are to comply with the EN 55015. The LED lighting and control gear should also comply with the relevant electromagnetic compatibility standards.
- 6.7. Luminaires shall have a colour temperature as dictated in the lighting schedule, typical values as follows;
 - 6.7.1. Domestic, communal living Warm 2000K
 - 6.7.2. Circulation areas, toilets, etc. Warm White 3000K
 - 6.7.3. Office, administration etc. Cool White 4000K
 - 6.7.4. Surgical theatres, etc. Daylight White 6000K
- 6.8. Luminaires shall have a colour rendering value as dictated in the lighting schedule, typical values as follows;
 - 6.8.1. Circulation areas, toilets, etc. >80Ra
 - 6.8.2. Food prep/display, surgical >90Ra
- 6.9. The minimum McAdam Ellipse value shall be 3 at a minimum. SDCM<3.
- 6.10. Luminaires shall have a Power Factor >0.9.
- 6.11. LED PCBs / modules shall be replaceable should a failure occur.
- 6.12. LED PCBs shall be protected with LED PROTECT (PLEDs), the failure of one LED shall not cause others in the group to extinguish. If there is a failure of a single LED other LEDs in close proximity shall brighten slightly to compensate.
- 6.13. All drivers shall be independently tested and shall display the ENEC European Safety Mark.
- 6.14. All luminaires shall have an approved type earth terminal (5 mm diameter stud) mounted on the gear tray adjacent to the mains terminal block which shall give effective earthing to the complete luminaire when connected to the system earth busbar.

- 6.15. Each luminaire shall be supplied and delivered as a complete unit including reflector/diffuser, mounting brackets and suspension kits where applicable.
- 6.16. Each luminaire shall be fully tested in accordance with the standards outlined in this section following assembly and shall be guaranteed for a minimum period of twelve months against faulty workmanship, materials and design. In such circumstances, the Contractor shall make good the defect either by repair or replacement and shall bear all associated costs including the cost of carriage on the return of the defective goods or parts and shall deliver any repaired goods to the site.
- 6.17. Full technical details of luminaires shall be made available at the time of submission of tender. The specialist supplier shall make one sample luminaire of each type available for inspection by the Engineer within one week of being requested to do so following submission of the tender.
- 6.18. The design of diffuser type luminaires shall ensure even flashing of the diffuser.
- 6.19. Recessed luminaires shall be supplied suitable for fixing to the ceiling grid and also with four standard conduit support outlets before ordering. Prior to providing a technical submittal the Contractor shall confirm the specific ceiling system being procured and installed by the Main Contractor and confirm the suitability of luminaires in conjunction with the ceiling system with the supplier.
- 6.20. Surface/suspended type luminaires shall have two standard conduit support outlets spaced at 600 mm centres, unless determined otherwise by the Contractor. Conduit boxes for suspended fluorescent type luminaires shall be provided with ball-and-socket covers spring-loaded with captive screws and earth link. Pendant conduits shall be 20 mm dia. 900 mm long and terminate in screwed dome covers affixed to the luminaire.
- 6.21. All luminaires shall be so designed that after installation, subsequent maintenance can be carried out from the underside of the luminaire following removal of the diffuser land/or coverplate.
- 6.22. Through-wiring facilities shall be available by means of knockout conduit entries in the ends of the gear housing or spine.
- 6.23. Diffusers shall be one piece, injection moulded, acrylic prismatic or opal type as specified. Polycarbonate diffusers shall be fitted in all plant areas and any areas likely to be subjected to vandalism. They shall be elastic light in weight and highly resistant to breakage. Each diffuser shall bear the manufacturer's catalogue number and trade mark or other means of positive identification.
- 6.24. Luminaires for general office and commercial use shall have a D.L.O.R. of at least 0.65.
- 6.25. The specialist supplier shall provide information to prove that luminance values shall not exceed 1000 cd/m² above 65° or 55° in special applications.

7. 4000K COLOURED NEUTRAL WHITE LIGHT LED SPECIFICATION:

- 7.1. Minimum 100 lumens per Circuit Watt
- 7.2. 50K hours lifetime and lumen depreciation of L80B50 minimum.
- 7.3. CRI>80. Colour Rendering should be 80 or above.
- 7.4. UGR<19. Glare to be less than 19
- 7.5. SDCM<3. The minimum McAdam Ellipse value is 3
- 7.6. This represents a value of 4000K +/- 75K so it can be as much as 4075K or as little as 3925K.

8. 3000K COLOURED WARM WHITE LIGHT LED SPECIFICATION:

- 8.1. Minimum 75 lumens per Circuit Watt.
- 8.2. 50K hours lifetime and lumen depreciation of L80B50 minimum target.
- 8.3. CRI>90. Colour Rendering should be 90 or above for warmer coloured light
- 8.4. UGR<19. Glare to be less than 19
- 8.5. SDCM<3. The minimum McAdam Ellipse value is 3.
- 8.6. This represents a value of 4000K +/- 75K so it can be as much as 4075K or as little as 3925K.

9. EMERGENCY LIGHTING:

- 9.1. As scheduled a number of the fluorescent luminaires shall be fitted with a self-contained, non-maintained battery and inverter pack to operate one lamp within the luminaire. The standards and characteristics of the emergency battery/inverter pack and the composite luminaire shall be as described in the Appendix attached to the rear of this Specification.

- 9.2. Where possible the emergency pack shall be mounted within the luminaire provided this can be achieved without detrimental effects to the luminaire or emergency pack and that the composite fitting can fit in the void. Where this is not possible the emergency pack shall be placed in a suitable enclosure and mounted to the body of the luminaire, or, in the case of very limited ceiling void (90 mm), adjacent to the luminaire with the appropriate connecting leads installed.
- 9.3. The specialist supplier of the composite luminaire will be required to assume complete responsibility for its compliance with the required standards and characteristics.

APPENDIX 5

EMERGENCY LUMINAIRES

1. GENERAL

- 1.1. The specified emergency luminaires must be utilised unless prior (written) agreement with the responsible engineer has been secured.
- 1.2. The party that is proposing a change to the specified emergency luminaires shall do so at entirely their own cost.
- 1.3. The pre-approval process is outlined below (Section 2).
- 1.4. **Notwithstanding the criteria detailed in Section 2, Varming Consulting Engineers Ltd. is under no obligation to agree to any proposed change(s).**

2. PRE-APPROVAL PROCESS

- 2.1. Emergency luminaires and equipment offered shall comply with all relevant Standards and Codes of Practice insofar as they apply.
- 2.2. Emergency luminaires shall be supplied complete with lamps.
- 2.3. The general criteria associated with a change to the specified emergency luminaires shall comprise of the following considerations.
 - 2.3.1. Emergency Luminaire data sheets
 - Conformance certificates from manufacturer within Europe or via an independent test-house (for a non-European jurisdiction)
 - Battery pack requirements (discharge duration, self-contained (integral), external/remote mounting requirements (if necessary))
 - Self-test communications requirements (if any)
 - Lamp efficacy
 - Luminaire power factor
 - Life span
 - Warranty on fittings
 - IP rating

- IK rating (mechanical impact)
- Luminaire suitability for the environment in which it will be installed
- All (luminaire control) drivers shall be independently tested and shall display the ENEC European Safety Mark.
- Electrical Supply arrangements (including earthing, class I and class II (and class III where relevant))
- Lamp colour
- Colour rendering
- Luminaire reflector/diffuser arrangements
- Luminaire mounting arrangement (incorporating removable covers for maintenance where required)

2.3.2. Emergency Lighting design file that meets the design specification as provided by Varming Consulting Engineers Ltd., which include specifics concerning the following on the stated working plane.

- Power consumption (W/m²)
- Illuminance (average, minimum and maximum)
- Glare
- Uniformity
- Maintenance factors
- D.L.O.R / U.L.O.R values

2.3.3. Lamps/luminaire availability (within the project timeline).

2.4. All (luminaire control) drivers shall be independently tested and shall display the ENEC European Safety Mark.

2.5. All batteries shall be manufactured the same year as the luminaire submittal is made.

3. COMPLIANCE WITH STANDARDS:

3.1. The luminaires shall comply with all relevant Irish and British Standards and Codes of Practice and in particular with the following:-

- I.S. 3217:2013, Code of Practise for Emergency Lighting
- BS. EN 1838:2013, Lighting Appliances - Emergency Lighting
- I.S. EN 13032-1:2004 / AI:2012 Light and Lighting - Measurement and Presentation of Photometric Data of Lamps and Luminaires. Part 1:Measurement and File Format

- I.S. EN 13032-2:2004 / A8:2007, Light and Lighting - Measurement and Presentation of Photometric Data of Lamps and Luminaires. Part 2: Presentation of Data for Indoor and Outdoor Work Places
- I.S. EN 50171:2001, Central Power Supply Systems
- I.S. EN 50172:2004, Emergency Escape Lighting Systems
- I.S. EN 60529:1993/A2:2013, Degrees of Protection Provided by Enclosures(IP Code)
- I.S. EN 60598-2-22:2014, Luminaires Part 2-22: Particular Requirements - Luminaires for Emergency Lighting
- I.S. EN 62034:2012, Automatic Test Systems for Battery Powered Emergency Escape Lighting
- 2006 / 42 / EU Machinery Directive
- 2014 / 35 / EU Low Voltage Directive
- 2014 / 30 / EU Electromagnetic Compatibility Directive

4. ELECTRICITY SUPPLY:

- 4.1. Unless otherwise indicated, all luminaires shall be suitable for use with a 1-phase 2-wire 230 volt 50 Hz earthed neutral system (+6 -10%).

5. DESIGN:

5.1. GENERAL:

- 5.1.1. The emergency luminaires shall be completely self-contained and suitable for operation of 230V 50Hz supply.
- 5.1.2. The batteries shall be fully-sealed nickel cadmium alkaline cells capable after 24-hours charge of 3-hour emergency duration of rated output.
- 5.1.3. Each luminaire shall comprise an automatic battery charger, mains failure relay, battery, mains healthy indicator and inverter.
- 5.1.4. All components shall be adequately rated and of rugged construction to ensure reliable and fast-switching to battery supply when a mains failure occurs and to ensure that the components or charge require no maintenance during the life of the luminaire.
- 5.1.5. All emergency luminaires shall be installed in rigidly - framed steel enclosures, suitable for wall and bracket-mounting and fitted with one 20 mm entry (unless otherwise stated).

5.1.5.1. Battery and inverter packs provided for mounting external to the luminaires they serve shall be supplied complete within metal enclosures, or fire resisting/self-extinguishing sleeving, depending on access space available for installation and maintenance.

5.1.5.2. Cables from the luminaire to the enclosure greater than 1m in length shall be rated to classification PH120 as defined by I.S EN 50200:2006.

5.1.6. Each luminaire shall have a 10A 2-way mains connection block and M4 brass earthing stud fitted internally local to the conduit entry to facilitate connection to the supply system.

5.1.7. All luminaires shall be fully tested and the guarantee period (12 months minimum, 4 years for batteries) shall be stated at the time of tender.

5.1.8. The luminaire manufacturer shall provide documentation to confirm that the particular lamp and inverter / battery pack unit are compatible and have been fully tested in combination and that they conform to the standards stated.

5.2. WIRING

5.2.1. Each emergency lighting point shall be connected to the feed, neutral and switch wire of the local lighting circuit. The feeds shall be taken from the distribution board through normally closed contacts of relays operated by the central test unit and extended to each emergency point on that circuit. Wiring shall be as used for the normal sub-circuit.

5.3. BATTERIES

5.3.1. All batteries utilised in emergency light fittings shall be high temperature Sintered Plate Nickel-Cadmium (NiCD) or Nickel-Metal Hydride (NiMH), Secondary Cell type, Rechargeable.

5.3.2. All batteries shall be high temperature (55deg) and shall have the rated temperature indicated on the battery casing. All batteries shall be mounted within fittings and remote packs using battery holders to ensure that no part of the battery casing is in contact with the fitting or remote pack casing.

5.3.3. All battery packs used in emergency lighting luminaires shall be fully encapsulated and come complete with battery disconnect male/female connector(s) to aid isolation and service. All chargers and changeover controls shall be fully automatic and failsafe upon power failure or resumption of supply

5.3.4. Sealed Lead Acid (SLA) Batteries:

5.3.4.1. All rechargeable Sealed Lead Acid (SLA) batteries used in emergency light fittings shall be maintenance free and of a sealed leak proof construction. All batteries shall be valve regulated to prevent excess build up of gas. Valves shall automatically reseal upon venting. All batteries shall be capable of operating in any orientation and meeting the required duration of 3 hours for emergency lighting at the end of five years of usage.

5.3.4.2. The Operating Temperatures for SLA batteries used in emergency lighting shall be as follows:

Charge – 15°C to 50°C

Discharge – 20°C to 60°C

All batteries used in emergency lighting (NiCD, NiMH, SLA etc.) shall be dated with the date of installation

5.4. LAMPS

5.4.1. All lamps utilised as part of the emergency lighting system shall be suitable for the required purpose and be of major brand name manufacture only. All lamps shall be professional long life variants.

5.4.2. All double-ended lamps shall be capable of being run in emergency mode in any orientation i.e. are not dependant on the cold end of the lamp being fitted in the luminaire in one specific position.

5.4.3. No “pinking” of the lamps in emergency mode shall be accepted.

5.4.4. In all emergency lighting luminaries the LED status indicator light shall be visible while the luminaire operates under normal lighting supply.

5.4.4.1. i.e. it shall be possible to see a fitting is an emergency luminaire when it is switched on and operating under normal supply.

5.4.5. All lamps operating whilst supplies are available shall be at a ballast of unity. No under-running of lamps is allowable by combination mains/emergency ballasts in normal operation – the only exception to this applies to integral conversions in small form luminaries where use of a standard ballast would lead to a temperature within the fitting that would exceed the rated temperature of components - see table below for details. The emergency lighting supplier shall confirm in writing the fitting types using combination ballasts with the OPW engineer for the project prior to production of conversions.

- 5.5. Light Emitting Diode (LED) Fittings – (Fittings Supplied By The Emergency Lighting Supplier Excluding Exit Signs)
 - 5.5.1. All LED's used, unless otherwise stated, shall be based on a full cone distribution of between 100 and 70 degrees.
 - 5.5.2. All LED fittings shall utilise LED's that provide the following minimum efficacy: **45 lumens/Watt – Usable into the Room.**
 - 5.5.3. All LED's shall be rated for operating at 25°C ambient room temperature and a Tc(max) 75°C.
 - 5.5.4. All LED's used, unless otherwise stated, shall be Warm or Neutral White.
- 5.6. LABELLING OF EMERGENCY LIGHTING FITTINGS
 - 5.6.1. Each emergency light/luminaire and exit sign shall be labelled. The label shall be clearly visible from floor level so that a fitting can be clearly identified. The printed text on the label shall be as follows: **floor number / emergency luminaire number.**
 - 5.6.1.1. e.g. **02 / 17** would indicate emergency luminaire number 17 on the second floor.
 - 5.6.2. The electrical specialist shall supply upon completion of the project a logbook for the emergency lighting system for inclusion with the O&M manuals. The logbook shall contain a list of all emergency lighting luminaires for the project by location, label number and type, included also shall be A3 NTS drawings of the building showing the location of the as installed emergency luminaires complete with label numbers.
- 5.7. METALS AND PLASTICS
 - 5.7.1. All metals and plastics utilised as part of the emergency lighting luminaires shall be suitable for the required purpose.
- 5.8. OVERLOAD AND SHORT CIRCUIT PROTECTION:
 - 5.8.1. All emergency luminaires shall incorporate separate protection for each incoming supply line, to include the un-switched and switched supplies, integrally, within the luminaire by means of suitable fused terminal block(s) to aid safety, isolation and discrimination functions. All fused terminal blocks for the purpose of connection to the supply network shall be suitable sized for the connection in each terminal of at least 2 No. 1.5mm² cables or 1 No. 4.0mm² cable.

5.9. EXIT SIGNS

- 5.9.1. Decorative Blade Type: All exit signs of the decorative hanging blade variety which use top lit illumination shall have the running man, arrow and door symbols. The background colour of the blade shall be green and the running man, arrow and door symbols shall be white. All diffuser material either blade type or normal is to be made from polycarbonate.
- 5.9.2. All lamps operating whilst supplies are available shall be at a ballast of unity. No under-running of lamps is allowable by combination mains/emergency ballasts in normal operation.
- 5.9.3. Wiring within the exit sign shall not be loose or hanging and shall not be visible when the exit sign is illuminated.

6. TESTING AND INSPECTING

- 6.1. The Specialist Contractor shall include for the complete testing, pre-commissioning, commissioning, certification and handover of the emergency lighting system in accordance with I.S. 3217 (current edition).

APPENDIX 5A

BSRIA TECHNICAL NOTE TN21/97 DEFINITIONS

1. DRAWINGS:

The following suggested definitions may be used to clarify the design responsibilities incumbent on those required to produce each drawing or document. These definitions are supported by drawn examples included in TN22/97 "The Allocation of Design Responsibilities Example Drawings".

1.1. SKETCH DRAWINGS

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

1.2. SCHEMATIC DRAWINGS

- 1.2.1. A line diagram describing the interconnection of components in a complex system. The main features of a schematic drawing should be as follows:
 - 1.2.1.1. The drawing may be a two dimensional layout with divisions to show the distribution of the system between building levels. It may also be an isometric style layout indicating the distribution of systems across individual floor levels. The drawing would not necessarily be constructed to scale.
 - 1.2.1.2. The drawing should include all functional components which make up the system i.e. plant items, pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.
 - 1.2.1.3. Symbols and line conventions should be in accordance with a recognised source of standard symbols, such as BS1199:Part3:1987 "Recommendations for symbols and other graphic conventions".
 - 1.2.1.4. The drawing should indicate components which have a sensing and control function and should indicate the links between them e.g. building management systems, fire alarms and HV controls.
 - 1.2.1.5. The drawing should be labelled with appropriate pipe, duct and cable sizes where these are not shown elsewhere.
 - 1.2.1.6. The major components indicated on the schematic drawing should be identified so that their whereabouts in specifications and on other drawings can be easily determined.

- 1.2.1.7. If required to form part of a **commissioning specification**, the drawing should include all data essential to testing and commissioning including volumetric flow rates, design total pressure losses at equipment, locations of dampers, valves and flow measuring stations, electrical faults, levels, current ratings, short circuits capacities and tripping times.

NB: Where a design consultant is appointed to produce a scheme design for completion by a design and build contractor, only the first three of these requirements are likely to be appropriate.

1.3. DETAILED DESIGN DRAWINGS

- 1.3.1. A drawing showing the intended locations of plant items and service routes in such detail as to indicate the design intent. The main features of detailed design drawings should be as follows:
- 1.3.1.1. Plan layouts should be to a scale of at least 1:100. Plant areas should be to a scale of 1:50 and should be accompanied by cross sections.
 - 1.3.1.2. The drawing will not include the precise position of services, but it should nevertheless be feasible to install the services within the general routes indicated. It should be possible to produce **co-ordination drawings** or **installation drawings** without major re-routing of the services.
 - 1.3.1.3. Main wireways should be represented by single line layouts, different containment types should be represented by differing line types. Symbols and line conventions should be in accordance with a recognised source of standard symbols such as BS1192:Part3:1987 'Recommendations for symbols and other graphic conventions'.
 - 1.3.1.4. The drawing should indicate the space available for major service routing in both horizontal and vertical planes.

1.4. CO-ORDINATION DRAWINGS

- 1.4.1. A drawing showing the inter-relationship of two or more engineering services and their relation to the structure and building fabric. The main features of a co-ordination drawing should be as follows:
- 1.4.1.1. Plan layouts should be to a scale of at least 1:50 and accompanied by cross sections to a scale of at least 1:20 for all congested areas.
 - 1.4.1.2. The drawing should be spatially co-ordinated i.e., there should be no physical clashes between the system components when installed at the scaled-off positions shown on the drawing. In areas where tolerances are minimal, dimensions should be provided.

- 1.4.1.3. The spaces between pipe and duct runs shown on the drawing should make allowances for the service at its widest point. Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.
- 1.4.1.4. The drawing should be make allowance for those plant items specified by the designer and identified in the design specification.
- 1.4.1.5. The drawing should make allowances for installation working space and space to facilitate commissioning and maintenance.
- 1.4.1.6. The drawing should indicate positions of main fixing points and supports where they have significance to the structural design.
- 1.4.1.7. The services should be arranged in such a way that it is possible to demonstrate a feasible sequence of installation.
- 1.4.1.8. The drawing should be supported by “individual services drawings” where these are desirable for clarity.
- 1.4.1.9. Plant room layouts should be to a scale of at least 1:20 and be accompanied by cross sections and elevations to a scale of at least 1:20.

1.5. INSTALLATION DRAWINGS

- 1.5.1. A drawing based on the **detailed design drawing** or **co-ordination drawing** with the primary purpose of defining that information needed by the tradesmen on site to install the works

NB Where co-ordination drawings have not been prepared in advance, responsibility for spatial co-ordination should be allocated to the “lead” installing contractor who should be named in the tender documents. All installation requirements should then be produced taking into account the needs of co-ordination.

- 1.5.2. Main features of installation drawings should be as follows:

- 1.5.2.1. Plan layouts should be to a scale of at least 1:50 and should be accompanied by cross sections to a scale of at least 1:20 for all congested areas.
- 1.5.2.2. The drawing should be spatially co-ordinated, i.e. there should be no physical clashes between the system components when installed at the scaled-off positions shown on the drawing.
- 1.5.2.3. Allowances should be made for inclusion of all supports and fixings necessary to install the works.
- 1.5.2.4. The spaces between pipe and duct runs shown on the drawing should make allowance for the services at its widest point. Insulation, standard fitting dimensions and joint widths should therefore have been allowed for on the drawing.
- 1.5.2.5. The drawing should make allowances for installation details provided from *shop drawings*.

- 1.5.2.6. The drawing should make allowances for installation working spaces, space to facilitate commissioning and space to allow on-going operation and maintenance in accordance with the relevant health and safety requirements.
- 1.5.2.7. Allowances should be made for plant and equipment including those which are chosen as alternatives to the designer's specified option.
- 1.5.2.8. Dimensions should be provided where the positioning of the services is considered to be important enough not to leave to the tradesmen on site.
- 1.5.2.9. Plant room layouts should be to a scale at least 1:20 and be accompanied by cross sections and elevations to a scale of at least 1:20.

1.6. INSTALLATION WIRING DIAGRAM

- 1.6.1. Drawing showing the interconnection of electric components, panels etc. in accordance with the design intent indicated on the **schematic drawings** and incorporating the details provided on **manufacturer's certified drawings**.

1.7. SHOP DRAWINGS

- 1.7.1. Drawing prepared by a fabricator or supplier for a particular project, and which is unique to that project. examples include supplier's drawings for ductwork, pre-fabricated pipework, sprinkler systems, control and switchgear panels and associated internal wiring.

1.8. MANUFACTURER'S DRAWING

- 1.8.1. Drawing provided by a manufacturer or supplier to indicate a typical representation of the product, components or plant items to be supplied for a particular project.

1.9. MANUFACTURER'S CERTIFIED DRAWING

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

1.10. RECORD DRAWING

- 1.10.1. Drawing showing the building and services installations as installed at the date of practical completion. The main features of the record drawings should be as follows:
- 1.10.2. The drawings should provide a record of the locations of all the systems and components installed including pumps, fans, valves, strainers, terminals, electrical switchgear, distribution and components.
 - 1.10.2.1. The drawings should be to a scale not less than that of the installation drawings.
 - 1.10.2.2. The drawings should have marked on them positions of access points for operating and maintenance purposes.
 - 1.10.2.3. The drawings should not be dimensioned unless the inclusion of a dimension is considered necessary for location.

1.11. BUILDER'S WORK DRAWING

- 1.11.1. Design State Definition:
 - 1.11.1.1. A drawing to show the provisions required to accommodate the services which significantly affect the design of the building structure, fabric and external works. Most drawings (and schedules) of work to be carried out by building trade, and require to be costed at the design stage e.g. plant bases.
- 1.11.2. Installation stage definition:
 - 1.11.2.1. Drawing to show requirements for building works necessary to facilitate the installation of the engineering services (other than where it is appropriate to mark out on site).

1.12. SPECIALIST DRAWING

- 1.12.1. A generic term for those drawings which may be supplied by a specialist supplier or sub-contractor appointed to undertake design duties in relation to a specific aspect of the project.

1.13. TENDER DRAWING

- 1.13.1. Drawing produced for the purpose of obtaining competitive tenders. The tender drawings will comprise an agreed set of drawings to suit the complexity of the project, and which comply with the specific drawing definitions included in this section.

APPENDIX 7

SCHEDULE OF LUMINAIRES, WIRING ACCESSOIRES & SUPPLIERS

for the

TRANSFORMER UPGRADE WORKS

at

SUH

NOTES:

1. Alternative products/ systems to the Benchmark products/systems may be proposed but must be accepted by Varming in writing before proceeding. For such alternative products, provide full technical literature to demonstrate that the alternative proposals are of a standard at least equal to that identified and demonstrate compatibility with the design intent. This schedule must be read in conjunction with the relevant part of the Specification.
2. In these specifications trade names and or suppliers are sometimes used for the purpose of brevity and clarity of technical, aesthetic, functional, maintainability, after sales service, energy and life cycle cost intent. Such references are for the conveniences of the tenderer in clearly indicating the standard of technical, aesthetic, functional, maintainability, after sales service, energy and life cycle cost requirements sought by the specifier. The intention is not to favour one product over another or to eliminate other products or suppliers.
3. Other materials / products may be put forward for consideration as equivalent materials / products to those stated in the specification once they meet the minimum criteria are set out within the tender documents and drawings.
4. Approval for substitution of equivalent materials / products shall be given where the alternative material / product are demonstrable by the electrical specialist contractor to be equal and in full accord with the original specification and drawings and once it is demonstrated that all substitution products have equivalent technical, aesthetic, functional, maintainability, after sales service, energy and life cycle costs.
5. Equivalence of an offered substitution shall be judged on the basis of objective, clear and verifiable criteria and independent proof of similar compliance with equal standards to those specified.
6. Where appropriate the electrical specialist contractor shall be required to issue verification by means of providing a detailed technical submittal, after sales commitment dossier, drawings, data sheets, energy and life cycle costs, test reports from a recognised body, samples of the material / product substitution to the client's representative and to the consulting Mechanical and Electrical Consulting Engineers. The electrical specialist shall implement an electronic system for managing and tracking all plant and equipment submittals. Any increased costs arising whatsoever from such any substitution in terms of redesign, time required for the employer's representative and consulting Mechanical and Electrical Engineers to review and evaluate substantial quantities or substantial detailed technical proposals for alternatives, rescheduling, health and safety issues etc. shall be borne by the Electrical Specialist Contractor.

7. Alternative suppliers / installers shall be required to prove their ability to perform their sub element part of the contract through the submission of proof of their technical and or professional capacity (education, experience, equipment, personnel etc.), including their ability to manage in an environmentally sound manner.
8. The contracting authority, through its architect who is the employer's representative in conjunction with the consulting Mechanical and Electrical engineers shall determine on a case by case basis, from a technical, aesthetic, functional, technical, aesthetic, functional, maintainability, after sales service, energy and life cycle cost perspective what constitutes an equal and equivalent standard / product. Verification shall take place only after the award of the contract, as part of the contract management regime. Sufficient time shall be allowed to check submissions and provide samples as indicated within the specification documents.
9. Fittings denoted by an E after the luminaire schedule symbol on the drawing are to be fitted with an addressable 3 hour emergency inverter pack for integration into the addressable emergency lighting system. All luminaire that require a 3 hour emergency back must be converted by the same supplier, such as Lighting Solutions, Ventilux, Profile, NEL, Em Com, PlusLite or equal and approved 3 hour emergency inverter pack.
10. The Contractor shall confirm all reference number correspond to the description of the items on this schedule.
11. The Contractor shall provide samples as required and requested by the design team.

LUMINAIRE SCHEDULE

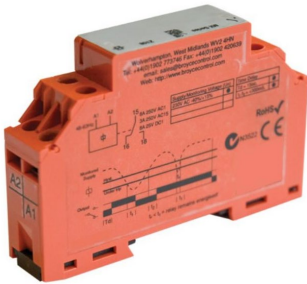
REF.	LOCATION	DESCRIPTION	IMAGE
P	Plantroom	Surface & Suspended mounted fitting as manufactured by Fagerhult. 39321 KAPTUR IP67. Ra 80+ L90/B50 50K. Life expectancy of the LED 50,000 hours, when the light output has reduced to 90% of its initial level and when 50% of the LEDs have failed to meet operational expectations 6136 lm LL/CW 159 Luminaire lumens per circuit watt, the luminaire efficiency including ALL optical and gear losses.	 

EMERGENCY LUMINAIRE SCHEDULE

REF.	DESCRIPTION	
EB High Risk Areas	FIREscape NFW89/0 - High Power Open Space Down Light Addressable open space down light featuring one high-powered LED with a specially engineered dual surface free-form optic. The unit's body contains the electronics and the stand-by battery and features a bi-coloured LED indicating charge/fault status (green for charging, red for fault). The unit shall be supplied complete with Hochiki's standard sensor base, YBN-R/3(WHT). The unit shall be supplied complete with Hochiki's NF89BAT rechargeable battery. IP20 a dome enclosure shall be provided, NFW68/89-IP64	

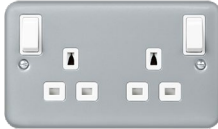
REF.	DESCRIPTION	
EX External	FIREscape N68-0-3 - Open Space Down Light Addressable open space down light featuring one high-powered LED with a specially engineered dual surface free-form optic. The unit's body contains the electronics and the stand-by battery and features a bi-coloured LED indicating charge/fault status (green for charging, red for fault). The unit shall be supplied complete with Hochiki's standard sensor base, YBN-R/3(WHT). The unit shall be supplied complete with Hochiki's EL-BAT450 rechargeable battery. The unit shall be supplied complete with Hochiki's External Weatherproof Enclosure & Bracket, EL-DEB.	

REF.	DESCRIPTION	
EXIT	FIREscape EL-20 - 20m Emergency Exit Sign Frame The unit shall be supplied complete with Hochiki's standard sensor base, YBN-R/3(WHT). The unit shall be supplied complete with Hochiki's EL-BAT450 rechargeable battery. The unit shall be supplied with the appropriate Sign/Lens; EL-20G-D(ISO) EL-20G-L(ISO) EL-20G-R(ISO) EL-20G-U(ISO)	      

REF.	DESCRIPTION	
ELP	FIREscape EL-2 Addressable Emergency Lighting Control Panel To include the FIREscape EL-35V Transformer, FIREscape EL-LAN Terminal Server (TCP/IP-RS232 Converter), FIREscape Installation & Maintenance Package, FIREscape Graphics Package, FIREscape User Licenses and FIREscape Server Licences. The system shall be supplied complete with a client PC.	
IO	FIREscape EL-IO Addressable Emergency Lighting Input/Output Unit I/O unit which is connected to a line of the EL-2 Emergency Light Control Panel, from which it receives its power. The unit links test switches and phase monitors to the FIREscape system..	
PM	FIREscape EL-PM Phase Monitor Relay Unit Under-voltage monitoring device that constantly assesses the condition of a mains lighting circuit. When the lighting circuit is deemed faulty, the unit will provide a signal that can be relayed to the control equipment to initiate emergency luminaire activation. To be supplied to the Distribution Board Manufacturer for installation in the distribution boards.	
EKP	FIREscape EL-KP Addressable Emergency Lighting Control Panel Keypad One EL-2 control panel can support a total of 8 EL-KP keypad units, with up to a max of 15 panels on one system.	

All Luminaires are to be supplied complete with lamps, transformers/power packs, mounting brackets and fixings. Dimmable options to be provided where applicable.

WIRING ACCESSORIES SCHEDULE PLANT AREAS

REF.	DESCRIPTION	MANUFACTURER	
1PH	IP67 rated lockable single phase isolator	ABB	
3PH	IP67 rated lockable three phase isolator	ABB	
	Top conduit (M20) entry. Metal Clad	Click Litehouse	
IP66	Aquip66	Click Litehouse	

All items are to be supplied complete with accessories and fixings as appropriate.

FIRE ALARM SCHEDULE

REF.	DESCRIPTION	MANUFACTURER	
S	Photoelectric smoke detector.	Hochiki Part No. ALN-EN(WHT)	
H	Heat detector.	Hochiki Part No. ATJ-EN(WHI)	
	Base	Hochiki Part No. YBO-R/3(WHT)	
	Isolating Base	Hochiki Part No. YBO-R/SCI(WHT)	
	Addressable Base Sounder	Hochiki Part No. YBO-BS(WHT)	

REF.	DESCRIPTION	MANUFACTURER	
	Remote Indicator.	Hochiki Part No. CHQ-ARI(WHT)	
B	Manual call point with integral short-circuit isolator.	Hochiki Part No. HCP-E (SCI)	
	Sounder beacon.	Hochiki Part No. CHQ-WSB2	
I/O	Input/Output Unit.	Hochiki Part No. CHQ-DIM(SCI)	
ASP	Aspirating smoke detector.	ICAM by xtralis ICAM IFT-6	

25672

REF.	DESCRIPTION	MANUFACTURER	
	Aspirating smoke detection pipe System to be supplied complete with the appropriate vesda accessories and fixings as indicated by the fire alarm specialist.	Vesda by xtralis	

APPENDIX 8

UNDERGROUND CABLE INSTALLATION

1. PROCEDURAL:

- 1.1. The Contractor is provided with the following:
 - 1.1.1. Proposed Underground Cable Layout Drawings.
 - 1.1.2. An individual underground cable installation specification sheet.
- 1.2. The contractor will provide amended draft layout drawings outlining any amendments made. An updated individual intruder alarm specification sheet will be provided for each draft also.
- 1.3. The iterative draft processes outlined in sub section 1.2 is continued until agreement is achieved between the responsible engineer and the nominated alarm contractor.
- 1.4. Once formal written agreement is received by the contractor including the agreed underground cable layout drawing, the underground cable installation may commence. It is only at this stage that the works are confirmed.

2. GENERAL:

- 2.1. The Main Contractor shall provide a system of trenches, underground and cable ducts as indicated on the drawings and in accordance with the Specification.
- 2.2. All cables and cable ducts shall enter/leave buildings via puddle flanges supplied and fitted by the Main Contractor. Such puddle flanges shall be cast iron with drilled flange for the attachment of backing and sealing glands.
- 2.3. Underground cables shall be laid direct in trenches in open ground or in pipe ducts as indicated on the drawings. They shall be drawn through ducts under roadways, hardstandings, pavements etc.
- 2.4. All underground pipework terminating in buildings or manholes shall, after the final installation and testing of the cables, be appropriately sealed with a weak concrete mix approximately 25mm thick, by the Main Contractor.
- 2.5. Where cables are installed in underground PVC pipes only 'long radius' bends shall be used where cables rise out of the ground.

3. EXCAVATION & REINSTATEMENT & LAYING OF CABLES:

- 3.1. When cable trenches are opened, all cables shall be laid and the trenches shall be back-filled within 24 hours. At all times safety precautions shall be taken and arrangements made to prevent damage to the cables.
- 3.2. Turf and topsoil shall be removed carefully and preserved for reinstatement in their original positions.
- 3.3. Broken land drains and damage to other services shall be reported and indicated. Clearance shall be obtained from the responsible Engineer before back-filling the trench.
- 3.4. The excavation shall be kept free of water and properly shored up. Other services uncovered shall be adequately supported by slings or other means and be protected.
- 3.5. Before cables are laid, the bottom of the trench shall be evenly graded, cleared of loose stones and then covered with a 75 mm layer stone-free material, e.g. sieved topsoil or sand.
- 3.6. Power cable installation shall be facilitated in a manner that ensures that the cable does not incur damage.
- 3.7. When more than one cable is laid in a trench, the cables shall be spaced apart in accordance with their current rating, but subject to the minimum spacings specified in Table 1.
- 3.8. Cables are segregated from other services in accordance with Table 1. When this is not possible, 50mm thick concrete or stone tiles shall be used as separators.

Cable	MV Mm	LV mm	Comms. mm	Co-Axial mm	Piped Services mm
MV	50	300	600*	600	300
LV	300	25	450	300	300
Comms.	600*	450	50	50	225
Co-axial	600	300	50	50	225

* Crossing 304mm, Others 50mm min.

Table 1: Minimum Spacing of Cables (Parallel Runs)

- 3.1. After laying, the cables shall be covered with enough fine sieved earth (or sand where local ground is unsuitable) to ensure 50 mm cover after tamping. Warning covers as specified in Clause 3 shall be laid over the cables and the trench filled in and compacted.
- 3.2. Reinstatement shall be affected by back-filling in 100 mm layers and hand ramming the first two layers. Power rammers may be used for the remaining layers. The turf shall be replaced, and the level of the finished reinstatement shall not protrude more than 25 mm above the normal ground level. A higher standard of consolidation is required for excavations within shoulders and over runs. At those positions the final 100 mm of reinstatement shall be compacted by a power rammer until maximum possible compaction is achieved. Temporary reinstatement only of paved areas shall be carried out by the Contractor.

4. BURIED CABLES WARNING:

- 4.1. Warning tapes or slabs shall be provided over all cables buried direct or in pipe ducts.
- 4.2. Slabs shall cover the width of the cables they are marking and be laid end to end.
- 4.3. The slabs shall be laid 300mm from the finished surface or half the buried depth, whichever is the lesser.
- 4.4. The slabs shall be marked to indicate the services buried below.
- 4.5. Warning tape shall be provided at least 100mm above the slabs and shall be continuous, coloured yellow and have the highest voltage of the cables protected indicated at required intervals.

5. EXCAVATION, REINSTATEMENT AND LAYING OF CABLE DUCTS:

- 5.1. Ducts shall be of 100 mm minimum bore. They shall be of the material, manufacture and method of jointing as set down in IS EN 61386-24
 - 5.1.1. High density polyethylene (HDPE) pipes to IS 135, Class B.
 - 5.1.2. PVC pipes having high impact resistance EN 50086-2-4-N.
 - 5.1.3. Concrete pipes (joints should be spigotted).
- 5.2. Ducts for ESB cables shall be as 5.1.1., colour red, with "Danger Electricity Cables" at 150mm intervals on each length. Duct wall thickness shall be 3.8/4.1mm up to 125mm (O.D.) diameter and each length shall be 6,000mm.

- 5.3. Trenches for ducts shall be scooped out at all points where the sockets rest so that the body of the duct lies upon solid ground. In rocky soils a layer of loose earth shall be spread over the bottom of the trench and rammed to afford a bedding for the ducts. In water-logged or unstable soil, a concrete foundation for the ducts shall be provided.
- 5.4. Ducts shall be kept clear of gas and water pipes, drains, sewers and electrical plant by a minimum of 150mm.
- 5.5. Ducts shall be laid so as to provide the minimum cover and spacings specified in Clause 3.2 and 3.8 above.
- 5.6. Ducts shall be cleared in the presence of the responsible Engineer by means of a pressure plug or similar device that ensures duct integrity. Alternatively, a CCTV inspection may be employed.

6. SEALING OF DUCT ENTRIES TO BUILDINGS (INCLUDING SERVICE PIPES):

- 6.1. After the cables have been installed both the cable and exposed duct and shall be lapped with an intumescent fire-stopping compound, painted with epoxy paint to form a gas, water and fire barrier.
- 6.2. Spare ducts shall be sealed with an appropriate duct fitting or intumescent firestop where required, painted with epoxy paint to form a gas and fire barrier.

APPENDIX 9

PROPOSED CONTROL PHILOSOPHY

1. PREFACE:

- 1.1. SUH shall remain on its current generator control philosophy controlled via MDB2 and the existing generator.
- 1.2. The below control philosophy is outlined for OLB1.
- 1.3. When the future generators are installed, they shall be controlled via OLB1. The protective devices and the associated control equipment outlined below shall be installed in OLB1 as part of this contract.

2. TYPICAL EQUIPMENT TO BE INCORPORATED INTO MAIN SWITCHBOARDS FOR STANDBY GENERATOR OPERATION

GENERAL:

- 2.1. The following equipment is to be incorporated into OLB1 associated with standby generator operation by the LV Electrical Contractor:
- 2.2. The LV Electrical Contractor shall be responsible for the design of the entire control strategy for each of the 2 No. future standby generator systems in accordance with the proposed control philosophy document issued as part of the tender documents.
- 2.3. The LV Electrical Contractor shall supply and install all equipment to ensure the system operates in accordance with the existing and proposed control philosophy.
- 2.4. The LV Electrical Contractor shall prepare a detailed and comprehensive control document including drawings as part of the contract.
- 2.5. All components to be installed within the main switchboards associated with the standby generator operation shall be a CoMAp product. This is to ensure full integration of the new standby generators into the existing hospital site wide standby generator network.
- 2.6. All cabling to be integrated into the main switchboard for controlling the standby generator systems shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks.
- 2.7. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist as part of the contract. The LV Electrical Contractor shall also be responsible for the supply and installation of all external cabling and for issuing out schematic drawings clearly identifying all wiring requirements.

- 2.8. The primary trip shall be via the sub-station Transformer ACB. The secondary G10 trips shall be via the transformer MV breakers.

2.9. EQUIPMENT/WIRING TO BE INSTALLED WITHIN THE SWITCHBOARD TO FACILITATE GENERATOR OPERATION

GENERATOR 1

- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

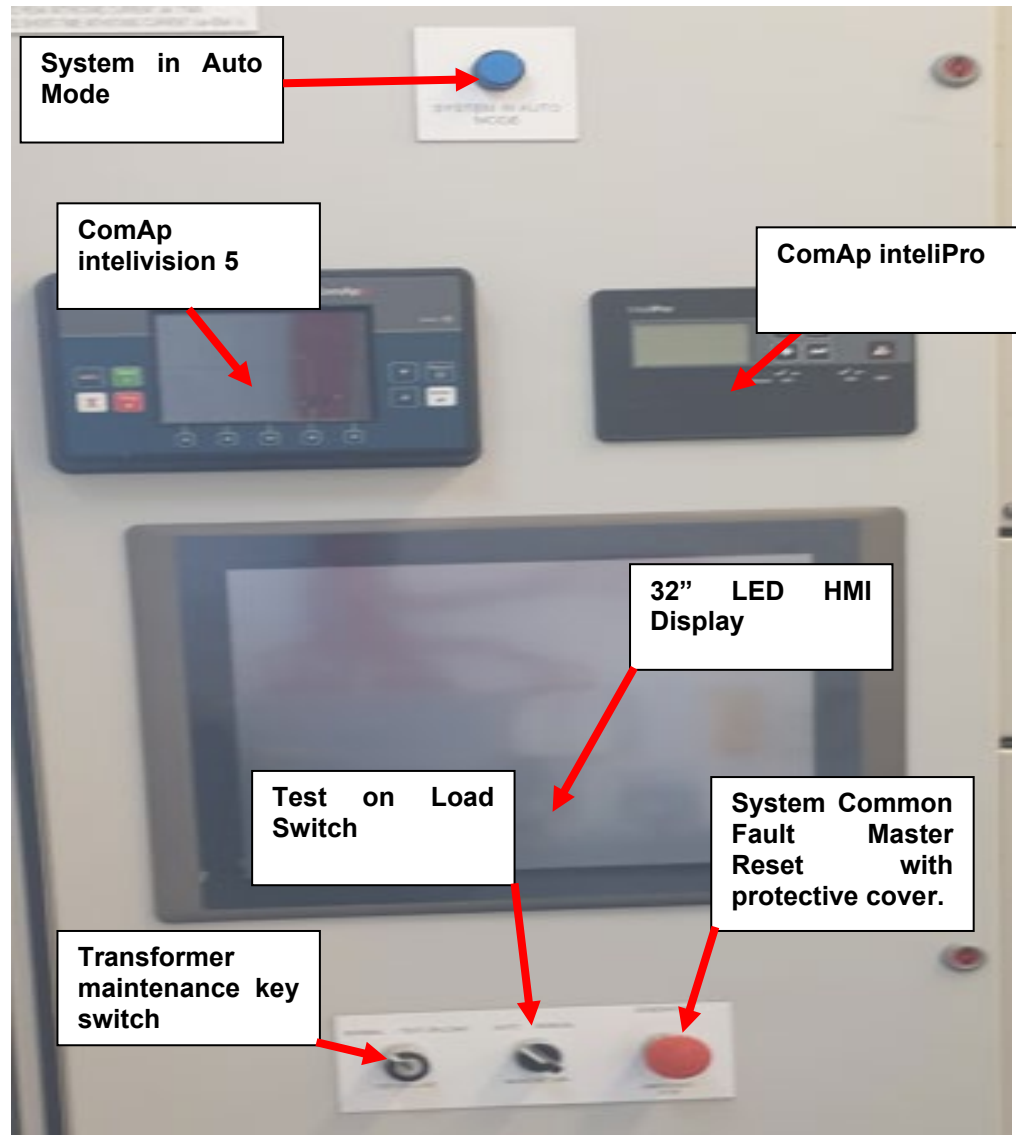
GENERATOR 1

- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Gen set controllers.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.

MAINS

- ComAp Inteli Pro Controllers (G10 Controller).
- ComAp Inteli IM-NTC-BB Controller.
- ComAp Inteli IVS Displays.
- ComAp Inteli IOB-B-A I/O expansion controllers.
- ComAp Inteli Protection relay for parallel operations.
- ComAp Inteli Comprehensive switchgear controllers.
- ComAp Inteli Utility Protection Relays.
- 32" LED HMI display shall be installed in the main new switchboard to associated with the Generator control philosophy system.

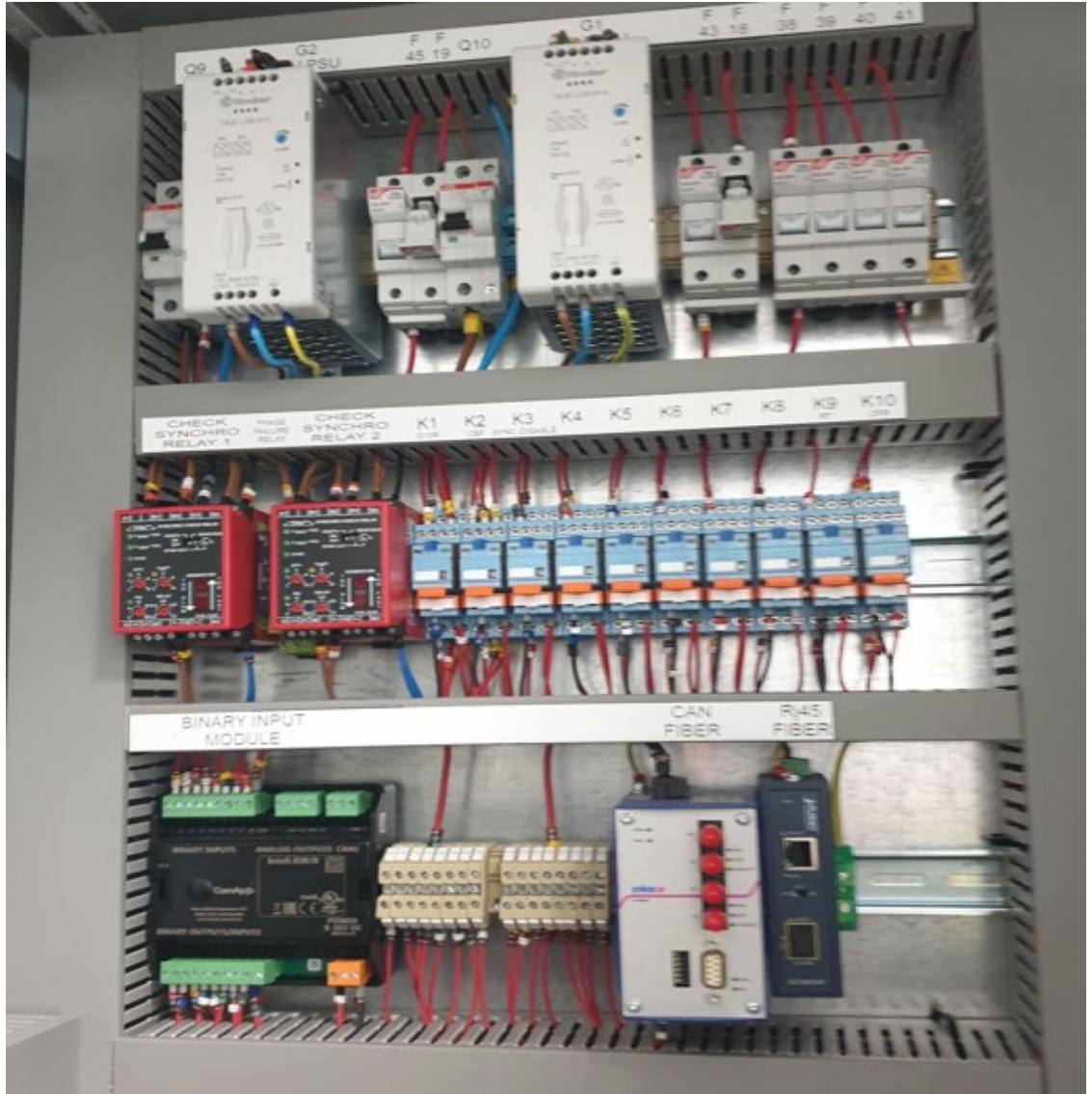
Note: All components must be a ComAp system to allow full integration into the existing ComAp standby generator hospital network.



TYPICAL MAIN SWITCHBOARD PANEL FACE.

The Off-Loading Switchboard OLB1 shall incorporate the following:

- **Test on Load Switch:** To allow standby generator system to automatically synchronise with the sub-station supply and operate in short term paralleling. When switch returned to normal position the standby generator system will again automatically synchronise with the sub-station supply and automatically return the sub-station to the normal supply.
- **Transformer Maintenance:** To allow the transformer to be maintained without loss of power to sub-station.
- **System Common Fault Master Reset** push button with protective cover.



TYPICAL NEW MAIN SWITCHBOARD COMPONENTS ARRANGMENT

ComAp 
The heart of smart control



Datasheet



Order code: INTELIPRO

Protection Relay for Parallel Applications

Product description

InteliPro is highly flexible protection relay for grid connected applications like generator sets, renewable energy sources, cogeneration, micro turbines, etc.

Key functions

- > Voltage, frequency and current based protections for on-grid distributed power generation

Key features

- > True RMS measurement
- > 3-phase voltage and current measurement
- > Automatic fault reset with adjustable time delay
- > Two stage protection settings
- > Optional functions for extended protection
- > Free assignment of 8 binary inputs, 9 binary outputs and 3 analog inputs
- > Full and easy configuration through the front panel or LiteEdit PC software
- > Expandable extensions and communication modules
- > Remote access
- > 3 level password protection
- > Event history log

Application overview



ComAp
The heart of smart control

**InteliGen NTC
BaseBox**



Order code: IG-NTC-BB
Gen-set Controller

Datasheet

Product description

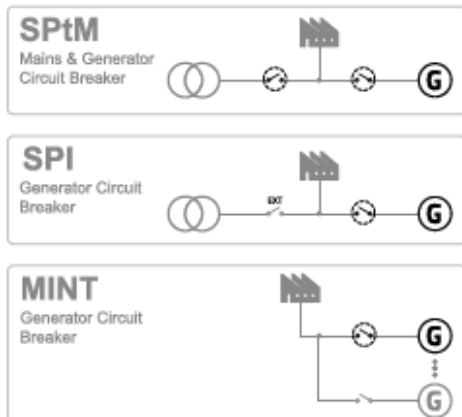
- ▶ Comprehensive paralleling gen-set controller
- ▶ Parallel operation up to 32 gen-sets
- ▶ High level control for complex systems
- ▶ CHP and gas engine controller

Key features

- ▶ Load sharing and VAR sharing via CAN
- ▶ Virtual shared inputs and outputs via CAN
- ▶ Support of wide range of applications
- ▶ Single or multiple gen-sets in parallel to mains operation with automatic back up function, multiple island operation
- ▶ Advanced power management function
- ▶ Customizable load control in parallel to mains
- ▶ Wide range of ECU support
- ▶ Extended communication capabilities
 - Built-in web server
 - Full Modbus slave support
 - GPS and AirGate support and more
- ▶ Highly configurable
 - Timers, Internal PLC, Force values and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Active e-mail messaging and SMS

- ▶ Extensive built-in protection functions
 - Standard protections
 - User configurable protection
- ▶ Extendable with ComAp's extension modules

Application overview



ComAp
The heart of smart control

**InteliMains
NTCBaseBox**



Order code: IM-NTC-BB

Comprehensive switchgear controller

Datasheet

Product description

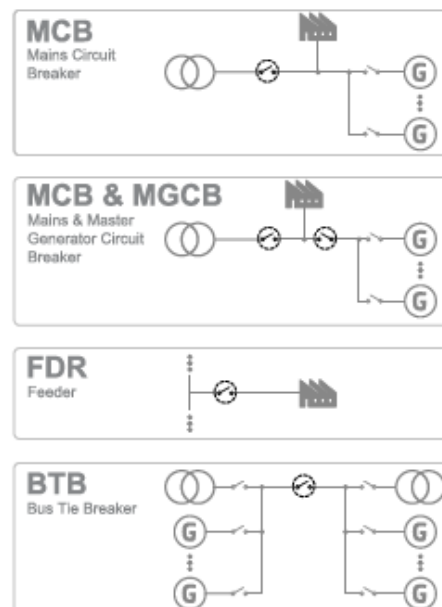
- ▶ Comprehensive switchgear controller
- ▶ Built-in control for up to 32 logic groups divided by Bus Tie Breakers
- ▶ High level control for complex systems

Key features

- ▶ Built-in breaker control
- ▶ Genset group synchronization, Loadsharing and Varsharing via CAN2
- ▶ Customizable load control in parallel to mains
- ▶ Extended communication capabilities
 - Built-in web server
 - Airgate support and more
- ▶ Highly configurable
 - Timers, internal PLC, Force value and more
- ▶ Compatible with ComAp's InteliVision displays
- ▶ Monitoring and configuration with ComAp's PC tools
- ▶ Extensive built-in protection functions
 - Undervoltage, overvoltage
 - Underfrequency, overfrequency and more
- ▶ Full Modbus slave support (RS232)
- ▶ Extendable with ComAp's extension modules

- ▶ True RMS (TRMS) is used with Voltage, Current and Power measurement

Application overview



3. GENERAL:

- 3.1. The following is a general description of the control philosophy required for OLB1.
- 3.2. The contractor shall prepare a detailed and comprehensive control document including drawings for the hospital.
- 3.3. The control philosophy applies to the FUTURE standby generator, the proposed new standby generator and integration into the MV/LV switchgear.
- 3.4. The afore mentioned control and protection equipment shall be incorporated into OLB1 by the switchgear specialist, to allow the FUTURE generator to synchronise with network.
- 3.5. The contractor shall supply and install a control system to provide the control of the standby generators as identified herein.
- 3.6. All internal wiring from the controllers to ACB, relays etc shall be provided by the switchgear specialist as part of the contract.
- 3.7. All external cabling to be integrated into the main switchboard for controlling the system shall terminate in an appropriate cubicle within the main switchboard complete with suitable terminal blocks. All cabling from the terminal blocks to the controllers, relays etc within the main switchboard shall be supplied and installed by the switchgear specialist.
- 3.8. All Main ACBs should have a 24V DC shunt opening coil and 230V shunt opening coil powered from the generator voltage and wired to the G10 controls.
- 3.9. Mains LV ACBs should have closing coils powered from mains.
- 3.10. Generator ACBs should have 230V UVR opening coil powered from the generator voltage and wired to two sets of terminals (one for generator controls and one for G10 controls).
- 3.11. Generator ACBs should have a 230V closing coil powered from the generator voltage.
- 3.12. All ACBs should have charging motors powered from the respective voltage.
- 3.13. 3 N/O & 2 N/C auxiliaries shall be installed on the mains ACBs and generator ACBs complete with tripped and racked out status.
- 3.14. Mains current 6 wires should be available from 5A measurement current transformers for the generator controllers.
- 3.15. Mains voltage should be available 3PH and N from 6A fuses.
- 3.16. 4 wire 400V 32A supply is required for generator auxiliary supplies.

- 3.17. Check synch /dead Bus relays required across each mains ACB, Generator ACBs and Coupler ACB.
- 3.18. Secondary G10 trips shall be via the transformer MV breakers MV1 and MV2. MV breakers shall come complete with relays/contactors etc for this function.

4. GENERAL CONTROL STRATEGY

Index of “Normal” Scenarios

- Normal operation: ESB supply healthy
- Mains /ESB Fails
- Mains return
- Brief Mains/ESB failure
- Test Off load
- Transfer to Generator / Test on Load
- G10 operation short term parallel
- Generator maintenance – safe isolation method.

Index of “Abnormal” or failure Scenarios (What if?) (the below scenarios are not included at this time but these and other what ifs! Can be implemented)

- ESB supplying load, mains fail. Mains ACB fails to open.
- Main ESB Circuit breaker trips on overload, system in Automatic, Generator not running
- Main ESB Circuit breaker opens OR is opened, system in Automatic, Generators not running
- Generator failure.
- MV Generator failures during a power failure.
- Site supplied by generator, Mains return sequence and Mains ACB Fails to close.
- Site supplied by generators, Mains return sequence - Gen breaker fails to open
- Site supplied by generators, LOSS OF COMMS FROM MASTER SYSTEM.
- Site supplied by Mains, LOSS OF COMMS FROM MASTER SYSTEM.

“Normal” Scenarios

Normal operation: ESB supply healthy

External Events	CONTROL SYSTEM ACTIONS
Mains Healthy and supporting site load	• Mains circuit breaker MCB closed • LV generator 1 not running • LV generator 2 not running • System in Auto • Generator circuit breaker (GCB) open • Site load supported from ESB supply • Mains MV healthy

Mains /ESB Fails

External Events	CONTROL SYSTEM ACTIONS
Mains failure: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • When synchronised the generator ACB's close. • Standby power LV generators 1 & 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generators 1 & 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy
External Events	CONTROL SYSTEM ACTIONS
Mains Manual Return if running on generators: Keyswitch in Manual position ComAp controller detects ESB within set-point limits	• When ESB Mains is available again system waits for 15 minutes before any action • LED indicates ESB Healthy • Key-switch in Position 1 "Manual return" • Operator chooses to restore Mains by turning Key-switch into position 0 "Auto return" • Main ACB closes under synchronous conditions i.e. (no blip return to mains/MV gens) • Generators 1 & 2 shall back off, and the mains supply will take up the load. • Generator 1 & 2 ACB's open. • Generators 1 & 2 run their cool down cycle. • Site load supported from ESB supply • Mains MV healthy

Brief Local Mains Failure

External Events	CONTROL SYSTEM ACTIONS
Mains failure: ComAp controller detects ESB set-point limits	• System waits for 5 seconds to see if ESB supply restores • If mains ESB returns under 5 seconds, then no action • Mains circuit breaker MCB does Not Open • System in Normal Operation

Test Off load for Service checks

External Events	CONTROL SYSTEM ACTIONS
Operator to change Genset controller from Automatic mode into Manual mode	• The operator will push the mode button from Auto to Manual • The operator will push the gen start pushbutton • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • Operator can note down generator parameters and carry out generator running checks • Note: NO Interruption to supply
Operator to change Genset controller from Manual mode to Automatic mode	• The Operator will push the gen stop pushbutton • The generator will go into cooldown and stop after a few minutes • If the Operator wants a sudden stop just press the gen stop pushbutton and the cooldown cycle will cancel and the generator will stop straight away • System reverts back to "Normal" • Operator to return generator controller from manual to automatic mode • Note: NO Interruption to supply

Transfer to Generator / Test on Load

External Events	CONTROL SYSTEM ACTIONS
Key switch : Position 1	• The operator will select key switch to position 1 for “Test on load” • After time period generator starts • LV generators 1 & 2 run up to stable speed and voltage. • LV generators 1 & 2 synchronise with each other. • LV generators 1 & 2 synchronises with mains supply and closes the generator ACB's • Generator ramps up on power and takes up the OLB2 site load • OLB2 LV ACB Opens • Standby power now powering OLB2 load • Note: No Interruption to supply
Key switch : Position 0	• The operator will select key-switch to position 0 for “Normal operation” • Test on load condition cancels • SUB3 LV MCB closes under synchronous conditions i.e. (no blip return to mains) • Site Supported on ESB Mains supply • Generator ramps down and GCB • Generator cools down and stops after a few minutes • System reverts back to “Normal”

G10 Protection – short term parallel

External Events	CONTROL SYSTEM ACTIONS
Generator in parallel with mains for short duration. Mains disturbance causes G10 protection to operate.	- G10 protection is “active” during parallel connection only - G10 protection operates (Trip condition) LV ACB is opened by G10 panel, site load supported from Generator - Generator continues to run on load until G10 fault is reset NOTE: if OLB2 LV ACB fails to Open on G10 fault then G10 control system will Open SUB3 10kv breaker as a secondary trip (per ESB G10 regulations). Manual restore required.
Recovery procedure: G10 manually reset at G10 panel Key switch for manual/auto return to mains to be in the AUTO position	- Operator will select “KS1” from “Test on load” position 2 back to “normal position” 0 - Test on load condition cancels - LV MCB closes under synchronous conditions i.e. (no blip return to mains/MV gens) - Site Supported on ESB Mains/MV gens supply - Generator ramps down and Opens ACB - Generator cools down and stops after a few minutes - System reverts back to “Normal”

Generator maintenance – safe isolation method.

External Events	CONTROL SYSTEM ACTIONS
Generator Maintenance Generator Controller – Pushbuttons Position 0 OFF	- Press the Estop on the generator control panel - This will render the entire system control unavailable for operation - Manually Open Set mounted circuit breaker - When works are complete return system back into automatic by reversing the above procedure - Ensure system is back in Automatic and No alarms

“Abnormal” Scenarios

ESB supplying load, mains fail. ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
ACB fails to Open	OLB2 Generator will not close ACB in this situation and bring up a breaker fail to operate alarms Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker MCB trips on overload, system in Automatic, Generator not running.

External Events	CONTROL SYSTEM ACTIONS
ACB Trips Open	Maintenance engineers to investigate issue and repair.

Main ESB Circuit breaker ACB opens OR is opened, system in Automatic, Generators not running.

External Events	CONTROL SYSTEM ACTIONS
Mains ACB Opens OR is Opened	If Mains ACB breaker opens for NO reason that System is aware of then generator control system will reclose the Mains ACB. If Operator wants to Open Mains ACB then he must put generator control system into Manual mode

Mains /ESB Fails, Generator Fails.

External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 1 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 2 run up to stable speed and voltage. • Generator 2 ACB close. • Standby power LV generator 2 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 2 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 2 shall back off, and the mains supply will take up the load. • Generator 2 ACB's open. • Generators 2 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer
External Events	CONTROL SYSTEM ACTIONS
Mains failure & generator 2 fails: System in Auto ComAp controller detects ESB voltage out of set-point limits at mains side of MCB +	• Mains ACB opens. • LV generators 1 run up to stable speed and voltage. • Generator 1 ACB close. • Standby power LV generator 1 now powering OLB1 load.
Automatic Mains Return: Keyswitch in Auto position	• Control system will Automatically detect return mains • After 15 minutes of stable mains the LV generator 1 synchronise with the mains supply. • When synchronisation is achieved the mains ACB will close. • Generators 1 shall back off, and the mains supply will take up the load. • Generator 1 ACB's open. • Generators 1 run their cooldown cycle. • Site load supported from ESB supply • Mains MV healthy • Maintenance engineers to investigate issue and repair. If deemed safe to do so, try reset alarm. Call in Generator Specialist On call engineer

Site supplied by generator, Mains return sequence and ACB Fails to close.

External Events	CONTROL SYSTEM ACTIONS
ACB Fails to Close	Maintenance engineers to investigate issue and repair. Generator control system will stay running on Generator until MCB is successfully Closed by control system

Site supplied by generators, Mains return sequence - Gen breaker ACB fails to open.

External Events	CONTROL SYSTEM ACTIONS
GCB Fails to Open	Maintenance engineers to investigate issue and repair. If ACB fails to Open after a three attempts generator will shut down and generator set mounted breaker should be opened so fault can be identified and rectified.

VOLT frees available to Others

Modbus connection is available from the generator Comap controller.

Volt free contacts are available from the generator up to a maximum of 4 without the need to add an expansion card to the generator control system.

Volt free contacts are available directly from the generator bulk fuel tank for tank level monitoring and bund leak.

These volt free signals are available to go to local BMS outstation.

VOLTFREE	Type	Comment
Gen running	DO	Signal closed = Generator running
Gen fault	DO	Signal closed = Generator fault
Genset NOT in Auto	DO	Signal open = Genset NOT in Auto
Fuel tank level low	DO	Signal closed = Fuel low
Fuel tank reorder level	DO	Signal closed = Fuel reorder
Fuel tank bund leak	DO	Signal closed = Bund leak
Modbus connection		Generator to Customer BMS

Engine Controller Configuration – generator controller.

Engine Inputs	CONTROL Function
- Emergency Stop - Oil Pressure - Water Temperature - Generator Circuit Breaker Status - Radiator Level - Over speed	Normally fail safe emergency stop circuit Digital Engine Low Oil Pressure Switch Digital Engine High Water Temperature Switch Status of the synchronising breaker; open and closed Digital input for Water Level (If available) Over speed
Engine outputs	CONTROL Function
- Fuel Solenoid - Electronic Governor - Starter Motor - Battery Charger On / Off control - Engine Heater On / Off control	Output to open the engine fuel for starting Power source for Speed controller, same configuration as Fuel solenoid Starter motor with adjustable RPM disconnect Disconnect battery charger on engine start / crank Disconnect Engine Heaters on engine start / crank
Engine Analogue Inputs	CONTROL Function
- Oil Pressure - Water Temperature - Engine Speed RPM - Generator Voltage - Generator Current	Engine mechanical protection; Low Oil Pressure Alarm & Shutdown Engine Mechanical protection; High Engine Water Temperature Alarm and Shutdown Engine speed derived from flywheel teeth Generator Bus Voltage reference; Voltage after generator synchronising breaker Generator Current Measurement
Engine Analogue Outputs	CONTROL Function
Not required	

APPENDIX 10 MEDIUM VOLTAGE INSTALLATION

1. GENERAL:

- 1.1. This specification outlines the general requirements for the supply and installation of the complete medium voltage distribution system.
- 1.2. The specialist supplier shall enter into a contract with the Contractor for the due performance of the works. The specialist supplier is advised to ascertain before submitting his tender his responsibilities and liabilities to the Contractor under this contract and to obtain details of the programme of the works as it affects this element of the project.
- 1.3. The object of this specification is to define the standards to which the high voltage distribution system is to be designed, installed, tested and commissioned and to identify the particular requirements and operation conditions of this installation.
- 1.4. Nothing in this specification shall relieve the specialist supplier from his responsibility to provide a safe and durable installation.

2. ELECTRICITY SUPPLY:

- 2.1. The existing MV network consists of 2 number radial MV supplies fed from the main MV energy centre MV1. This network shall be modified to provide an upgraded Transformer. To facilitate this a new Ring Main Unit will be installed for the new transformer T2 (MV2).
- 2.2. The medium voltage specialist recommended for the works is **HVSM LTD.**
- 2.3. The medium voltage specialist shall carry out a visual inspection of the existing hospital medium voltage network and prepare a report identifying the following:-
 - 2.3.1. The present settings of all sub-stations on the existing hospital network. As part of this exercise the medium voltage specialist shall prepare graphs, schedules and spread sheets clearly identifying all the present protective settings on the existing hospital medium voltage network.
 - 2.3.2. The proposed settings of all the sub-stations on the existing hospital MV network incorporating the new MV switch (MV2) on the existing Hospital medium voltage network. As part of this exercise the medium voltage specialist shall prepare graphs, schedules and spread sheets clearly identifying all the proposed protective settings on the medium voltage network.

- 2.4. Once the report has been approved by HSE and the design team, the contractor shall arrange for their medium voltage specialist to integrate/install the proposed protective settings into the upgraded medium voltage network. The time that the works shall take place shall be agreed with HSE and the design team. The works shall take place out of hours.
- 2.5. The contractor and their medium voltage specialist shall visit site during the tender period to review the existing HSE medium voltage network.
- 2.6. All interconnections/integration of the new MV Sub-station and the modifications to the exiting hospital Medium Voltage network shall be carried out by the contractor's specialist. The contractor shall modify the medium voltage network as detailed on the drawings.
- 2.7. All joints shall be manufactured by ABB. All joints shall be carried out by a specialist MV joiner appointed by the contractor as part of the contract. All shutdown works to the existing MV network shall be out of hours to minimise disruption to the SUH as detailed in Section 2 of this document. The contractor shall include for this within their tender

3. GENERAL DESCRIPTION OF THE SITE:

- 3.1. The following general description is intended to give an overall view of the works and does not relieve the tenderer in any way from taking account of all parts of the tender documentation.
 - 3.1.1. At present SUH hospital has a 10,000 volt supply taken from ESB Networks.
 - The existing switching arrangement within the client electrical energy centre (MV1) will be modified to suit the new Transformer T2.
 - A new Ring Main Unit will be installed to supply the new transformer (T2)
 - 3.1.2. MV1 is the main electrical energy centre for the entire hospital site. The MV cabling leaving the energy centre is distributed to T1 and MV2 on a 10/20kV cabling network. The contractor shall carry out a detailed survey of all sub-stations to obtain a good understanding of the existing MV network.
 - 3.1.3. The contractor shall appoint an MV operator for the entire duration of the project as part of the contract. The MV operators shall a minimum of 10 years' experience in the following areas:-
 - Project management of the installation of MV systems.
 - Supervision of the installation of MV systems.
 - Interfacing with ESB during shutdown of MV Networks.
 - Isolation of Client MV networks during shutdowns.

3.1.4. The MV operator shall be responsible for:

- Co-ordination of the entire works.
- Meeting with the Hospitals Facilities Engineer & Maintenance to arrange shutdown dates, obtain setting for new MV switchgear.
- Ensure that all setting for MV switchgear is programmed into the new MV switchgear by the MV switchgear supplier.
- Issuing of all programmes, method statements and permits of works.
- The isolation of the CLIENTS existing medium voltage network during all shutdowns. The MV operator shall have current training in the isolation of MV networks.
- Arranging all TELMOS documentation with ESB during the upgrade of the current ESB supply to the hospital.
- Prepare a detailed programme of works for each shutdown. This programme shall incorporate isolation procedures and persons responsible for the appropriate isolation. The programme shall be in excel format – clearly identifying each event, time that this shall take place and persons responsible.

NOTE: The MV operator shall be responsible for the isolation of the clients MV network during the shutdown works – this works will not be undertaken by the client. The MV operator shall liase with the Hospitals Facilities Engineer & and Engineer prior to the works to arrange all times for works. The final confirmation will ONLY be given by the Hospital Facilities Engineer DIRECTLY to the MV operator to isolate and re-connect the hospital MV network.

3.1.5. WORKS TO BE CARRIED OUT WITHIN THE EXISTING MV ENERGY CENTRE (MV2)

The Contractor shall supply and install a New Medium Voltage Ring Main Unit in the existing MV switchroom MV2 as part of the contract. The proposed new Medium voltage installation shall be in accordance with ESB rules and regulations for interfacing with ESB networks.

To accommodate the positioning of the Medium Voltage Ring Main Unit (MV2), the contractor shall:-

- Be responsible for the isolation of the clients MV network during the shutdown works – this works will not be undertaken by the client. The MV operator shall liase with the Hospitals Facilities Engineer & and Engineer prior to the works to arrange all times for works. The final confirmation will ONLY be given by the Hospital Facilities Engineer DIRECTLY to the MV operator to isolate and re-connect the hospital MV network.
- Isolate, disconnect and remove/dispose from site existing MV2.
- Supply, install, test and commission the new MV Ring Main Unit MV2.
- Test and commission the existing MV cabling from MV2 to the existing transformer T2, including any and all new power and control cabling as part of the contract.

- Supply, install, test and commission the new MV cabling from MV2 to the new transformer T2, including any and all new power and control cabling as part of the contract. In addition a new battery trip unit shall be installed. The contractor shall also test and re-commission the existing transformer system as part of the contract.
- The contractor shall supply and install a new earthing system as detailed on the relevant drawings and within this specification.
- Following the transfer of the LV Supply Service from the existing transformer (T2 – MDB2) to the new Transformer (T2 – OLB1 – MDB2) the MV Specialist shall allow for the removal of the existing T2 from the MV Supply. The MV Specialist shall be responsible for the isolation of the clients MV network during the shutdown works – this works will not be undertaken by the client. The MV operator shall liaise with the Hospitals Facilities Engineer & and Engineer prior to the works to arrange all times for works. The final confirmation will ONLY be given by the Hospital Facilities Engineer DIRECTLY to the MV operator to isolate and re-connect the hospital MV network.

3.1.6. CONTROLLED SHUTDOWN FOR WORKS.

The shutdowns for the Medium Voltage switchgear works shall take place at the weekend when a number of critical clinical procedures can be minimised. During the works, temporary synchronised duty standby generators will be operated, the affected areas of the hospital shall be powered from these generators. The contractor shall arrange as part of the contract for an Engineer from the temporary generator suppliers to be available for the entire duration of the shutdown – in the event of a standby generator failing.

As part of the contract, the contractor shall arrange for the rental of 2 No. Duty Standby Synchronised 1,250kVA standby-standby generator for the shutdown period. The standby-standby generator shall be positioned as detailed on the drawings. The contractor shall arrange for the standby-standby generator offloading cables to be run the relevant LV distribution centre for connection into the existing main switchboard MDB2. The offloading cables shall have the correct termination units attached to ensure that connection time to the existing main switchboard is kept to an absolute minimum. The contractor shall include for providing for the standby-standby generator fuel usage for the entire period of generator operation. The contractor shall be responsible for establishing the usage and incorporating the entire cost of this within the tender bid. A fuel storage tank shall be positioned adjacent to the standby-standby generator complete with the fuel. The pro-rate usage of fuel during the weekend will be reviewed after the works and the value deducted from the contract according to the fuel not used during the weekend period.

The contractor shall:-

- Install the duty-standby generators.
- Supply & install containment systems.
- Supply & install a new earthing system.
- Carry out MV and LV alterations as required to each area.
- Test and commission the entire system.

The contractors MV operator shall co-ordinate all the works with ESB, MV suppliers and the generator specialists. The MV operator will be present for the entire works and shall produce a detailed programme of works as identified above.

When the entire MV installation is tested and commissioned and power returned to the hospital, the existing hospital standby generator will be tested by the contractor to ensure that it operates correctly (automatic start) under mains failure. 2 mains failure tests shall be simulated

TEST 1: Contractor switching out the MV main Supply to the hospital.

TEST 2: Contractor switching out Main Switchboard MSB1.

The above tests will need to be carried out two times to ensure that the existing system is fully operational.

Dates for the weekend works shall be agreed with the Hospitals Facilities Engineer & Engineer

4. STANDARDS:

- 4.1. The MV switchgear shall be designed, manufactured and tested in compliance with the following standards and the particular requirements of the supply authority:

IEC 60694 Common specifications for high-voltage switchgear and controlgear standards
 IEC 62271 A.C. metal-enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 72kV and the IEC Code herein referred
 IEC 60129 Alternating current disconnectors (isolators) and earthing switches
 IEC 60529 Classification of degrees of protection provided by enclosures
 IEC 60265 High-voltage switches-Part 1: Switches for rated voltages above 1kV and less than 52 kV
 IEC 60056 Circuit breakers
 IEC 60420 High-voltage alternating current switch-fuse combinations
 IEC 60185 Current transformers
 IEC 60186 Voltage transformers
 IEC 60255 Electrical relays

Any other codes recognised in the country of origin of equipment might be considered provided that they fully comply with IEC standards. The design of the switchgear shall be based on safety to personnel and equipment during operation and maintenance, reliability of service, ease of maintenance, mechanical protection of equipment, interchangeability of equipment and ready addition of future loads.

5. GENERAL DESCRIPTION OF EQUIPMENT:

- 5.1. The new MV Switch MV2 shall be a 4 cubicle (CCVV) Ring Main Unit as supplied by ABB:
- 5.2. The new Transformer T2 shall be a 20/10 kV / 400/230 volt power distribution dual wound (**COPPER WINDINGS**) oil filled transformer 1.6MVA..

6. MEDIUM VOLTAGE SWITCHGEAR:

6.1. SERVICE CONDITIONS:

- 6.1.1. The switchgear and controlgear shall be suitable for continuous operation under the basic service conditions indicated below. Installation shall be in normal indoor conditions in accordance with IEC 60694.

- 6.1.1.1. Ambient temperature -25 oC to +40 oC

- 6.1.1.2. Relative humidity up to 95%

- 6.1.1.3. Altitude of installation up to 1000m, IEC 60120

6.2. GENERAL STRUCTURAL AND MECHANICAL CONSTRUCTION:

- 6.2.1. The Ring Main Units shall be of the fully arc proof metal enclosed, free standing, floor mounting, flush fronted type, consisting of modules assembled into one or more units. Each unit shall be made of a cubicle sealed-for life with SF6 and shall contain all the high voltage components sealed off from the environment.
- 6.2.2. The overall design of the switchgear shall be such that front access only is required. It shall be possible to erect the switchboard against a substation wall, with HV and LV cables being terminated and accessible from the front.
- 6.2.3. The units shall be constructed from 3 mm thick stainless steel sheets. The design of the units shall be such that no permanent or harmful distortion occurs either when being lifted by eyebolts or when moved into position by rollers.
- 6.2.4. The cubicle shall have a pressure relief device. In the case of an internal arc, the high pressure caused by the arc will release it, and the hot gases shall be allowed to exhaust out at the bottom of the cubicle. A controlled direction of flow of the hot gas is achieved.

6.2.5. The switchgear and controlgear should have the minimum degree of protection (in accordance with IEC 60529)

6.2.5.1. IP 67 for the tank with high voltage components

6.2.5.2. IP 2X for the front covers of the mechanism

6.2.5.3. IP 3X for the cable connection covers

6.2.6. Each unit shall be supplied with an operating handle.

6.3. RING MAIN UNIT – ELECTRICAL DATA & SERVICE CONDITIONS

6.3.1.	Rated voltage	kV	24
6.3.2.	Power frequency withstand voltage	kV	50
6.3.3.	Impulse withstand voltage	kV	125
6.3.4.	Rated frequency	Hz	50/60
6.3.5.	Rated current busbars	A	630
6.3.6.	Rated current (cable switch)	A	630
6.3.7.	Rated current (T-off)	A	200
6.3.8.	Short circuit breaking current (T-off circuit breaker)	kA	16
6.3.9.	Rated making capacity	kA	40
6.3.10.	Rated short time current 3 sec.	kA	16
6.3.11.	Service conditions		
	6.3.11.1. Ambient temperature		
	6.3.11.2. Maximum value	°C	+ 40
	6.3.11.3. Maximum value of 24 hour mean	°C	+ 35
	6.3.11.4. Minimum value	°C	- 25
6.3.12.	Altitude for erection above sea level	m	1000
6.3.13.	Relative humidity	max 95%	

6.4. PANEL (MODULE) DISCRIPTION

6.4.1. Incoming cable module

6.4.1.1. This shall consist of an SF6 cubicle housing a switch disconnecter and an earthing switch. Busbars and all electrical connections shall be located inside the tank. The operating mechanisms shall be located outside on the front of the SF6 tank. Cable bushings shall be located on the front of the SF6 cubicle in a separate cable compartment.

6.4.2. The T-off fuse protection module

6.4.2.1. This shall consist of an SF6 cubicle housing a position switch-fuse combination and earthing switch. The earthing switch shall be both upstream and downstream of the fuses and operated at the same time. The fuses shall be located in sealed fuse canisters. Busbars and all electrical connections shall be located inside the tank. The operating mechanisms shall be located outside on the front of the SF6 tank. Cable bushings shall be located on the front of the SF6 cubicle in a separate cable compartment.

6.4.3. The T-off circuit breaker module

6.4.3.1. The T-off circuit breaker module shall consist of an SF6 cubicle housing a circuit breaker unit and a disconnecter-earthing switch. An integrated relay and related CTs shall be used for tripping of the circuit breaker. Bus bars and all electrical connections shall be located inside the tank. The operating mechanisms shall be located outside on the front of the SF6 tank. Cable bushings shall be located on the front of the SF6 cubicle in a separate cable compartment.

6.5. CIRCUIT BREAKERS

6.5.1. Vacuum bottles shall be used as current interrupters. The circuit breaker main circuit shall be connected in series with a three-position disconnecter-earthing switch. The operation between circuit breaker and disconnecter-earthing shall be interlocked.

6.6. BUSBARS

6.6.1. These shall consist of the 3 single phase copper busbars and the connections to the switch or circuit breaker. The busbar shall be integrated in the cubicle or made available for external connection via a system with 400 series interface.

6.6.2. Busbars shall be rated to withstand all dynamic and thermal stresses for the full length of the switchgear.

6.7. THE CABLE SWITCH

- 6.7.1. This shall be a switch-disconnector and earthing switch using SF6 gas as an arc-quenching medium. The switch positions shall be closed – open – earthed. In the open position the switch shall satisfy the disconnector requirements.

6.8. EARTHING SWITCH

- 6.8.1. Earthing switches shall be rated equal to the switchgear rating.
- 6.8.2. Earthing switches shall be quick make type.
- 6.8.3. Earthing switch shall be operated from the front of the cubicle by means of a removable handle.

6.9. MECHANISMS

- 6.9.1. All mechanisms shall be situated in the mechanism compartment behind the front covers outside the SF6-tank.
- 6.9.2. The mechanism for the T-off switch and earthing switch should operate both switches via one common shaft. The mechanism shall be stored spring energy type and provide independent manual operation for closing and opening of the switch. The mechanism shall have a fuse tripping device.
- 6.9.3. The mechanism for the vacuum circuit breaker and disconnector-earthing switch should operate the CB and the disconnector-earthing switch via two separate shafts. The mechanism for the CB shall be stored spring energy type and provide independent manual operation for closing and opening of the CB. The mechanism shall have a relay with related CT's and/or remote tripping device..

6.10. PROTECTION RELAYS SHALL BE OF THE SOLID STATE TYPE WITH THE FOLLOWING FEATURES:-

- 6.10.1. Overcurrent, short circuit and earth fault protection.
- 6.10.2. Positive and latching indication of the particular element causing the trip.
- 6.10.3. Manual reset.
- 6.10.4. Accuracy better than + or – 10% over complete range of adjustable pick-up from minimum ground fault response to instantaneous pick-up point.

- 6.11. All cable boxes shall be suitable for termination of the cables shown.

6.12. BATTERY TRIPPING UNIT:

- 6.12.1. The switchgear shall be provided with a battery tripping units, comprising battery charger unit, sealed nickel cadmium battery complete with battery status and power supply monitoring relays with remote alarm facilities. The battery and charger units shall be adequately rated for the duty requirements in each case but shall not be less than 4 Ah.
- 6.12.2. The battery tripping units shall be housed in a heavy duty stove enamelled steel case with hinged face plate.

6.13. INSTRUMENT TRANSFORMERS:

- 6.13.1. Current transformers (CT's) for protection purposes shall have accuracy class designation 5P10. CT's for instrumentation purposes shall have accuracy Class 1 designation and instrument security factor compatible with the instruments selected but not exceeding $F_s = 5$.
- 6.13.2. Current transformers shall have rated output and ratio compatible with burden and rated primary current respectively. The nominal secondary current of all CT's shall be 5A.
- 6.13.3. Voltage transformers shall have accuracy Class 1 designation ratio 10,000 : 100 and shall have output compatible with 1,732 burden. CT's shall have primary and secondary protection fuses.
- 6.13.4. All instrument transformers shall be of the encapsulated resin type.
- 6.13.5. In systems with generators operating on MV system, there shall be an open delta voltage transformer with an earth fault relay, for use in island mode.

6.14. FINISH:

- 6.14.1. All metalwork shall be epoxy coated in manufacturers standard colour finish.

6.15. DEGREE OF PROTECTION:

- 6.15.1. All equipment, for installation indoors, shall be protected in IP35 as defined by IS EN 60529.

6.16. AUXILIARY CONTACTS:

- 6.16.1. All switching devices, relay functions, solenoids etc., shall be provided with 3 No. sets of normally open and 2 No. sets of normally closed contacts, in addition to those required for control and interlocking purposes. These contacts shall be wired to terminals for central plant monitoring/supervisory system.

6.17. SUNDRIES, TOOLS, ETC.:

- 6.17.1. All sundries, such as cable lugs, glands etc., for the main cables, all internal labels, small wiring and terminals shall be supplied with the switchgear.
- 6.17.2. All special tools and tackle necessary for the complete installation and maintenance of the switchgear shall be supplied at each switchboard location and shall be mounted in a suitable wall-mounted tool rack.
- 6.17.3. Five good quality brass padlocks of Lips manufacture, with non-interchangeable keys, shall be provided for each cubicle and handed over on completion of tests.

6.18. TESTING AT WORKS:

- 6.18.1. The following tests shall be carried out at the manufacturer's works prior to delivery to site. The Engineer shall be notified at least 3 working weeks in advance of testing in order that the tests may be witnessed if deemed necessary.
 - 6.18.1.1. Full mechanical inspection and functional checking of all switching operations, interlocks etc.
 - 6.18.1.2. Dielectric test on each phase to earth with remaining phases earthed - 50 kV RMS for one minute.
 - 6.18.1.3. Dielectric test - 2 kV RMS for 1 minute on LV wiring.
 - 6.18.1.4. CT polarity and ratio proving.
 - 6.18.1.5. Full testing of protection relays and electrical operation by primary current injection.
- 6.18.2. The results of the above tests shall be recorded and together with copies of type test certificates, shall be forwarded to the Engineer at the time of equipment delivery.

6.19. TESTING ON SITE:

- 6.19.1. The following tests shall be carried out on site in the presence of the Engineer prior to energising:
 - 6.19.1.1. Full mechanical inspection and functional checking of all operations, interlocks, etc.
 - 6.19.1.2. Dielectric tests as stated for testing at manufacturer's works but with test voltages reduced to 85% of works test values.
 - 6.19.1.3. Testing and setting of protection relays. Testing by either primary or secondary current injection method is acceptable for site tests.

6.19.2. The results of the site tests shall be recorded and copies forwarded to the Engineer within 10 days of completion the tests.

7. POWER DISTRIBUTION TRANSFORMERS (OIL-FILLED):

7.1. STANDARDS:

7.1.1. The transformer shall be designed, manufactured and tested in compliance with the requirements of:

IS EN 60076 – Power Transformers

IEC 60270 Testing technologies with high voltage partial discharge measurements.

IEC 61378-1 Converter transformer – Section 1 : Transformers for Industrial Applications.

IEC 60076-6 Reactors.

7.1.2. And in accordance with the particular requirements of the Supply Authority.

7.2. GENERAL:

7.2.1. The distribution transformer shall be of double wound core type, naturally cooled, fully rated for continuous operation to the ratings indicated. Enclosures shall be of welded steel plate construction on rigidly formed undercarriages and the complete units shall be effectively treated and painted to avoid rusting.

7.3. STANDARD REQUIREMENTS:

7.3.1. All transformers shall be provided with the following accessories as standard:-

7.3.1.1. Lifting lugs

7.3.1.2. Jacking pads

7.3.1.3. Earthing studs

7.3.1.4. Rating plate

7.3.1.5. HV cable box

7.3.1.6. LV cable box

7.3.1.7. Off circuit tap changer

7.3.1.8. Terminal marking plates

7.3.1.9. 250 CL tin of touch-up paint.

7.4. PARTICULAR REQUIREMENTS:

7.4.1. Transformers shall be provided with the following accessories where detailed in Schedule 'A' at the rear of this Appendix.

7.4.1.1. Transformer mounted conservator tank

7.4.1.2. Conservator tank oil level gauge.

7.4.1.3. Conservator tank supply line valve

7.4.1.4. Conservator tank drain valve and drain line

7.4.1.5. Bucholz relay (2 circuit)

7.4.1.6. Thermometer pocket

7.4.1.7. Dial thermometer (2 circuit)

7.4.1.8. Winding temperature

7.4.1.9. Pressure relay

7.4.1.10. Radiator isolating valves

7.4.1.11. Radiator air vent

7.4.1.12. Radiator drain valve

7.4.1.13. Tank top drain valve

7.4.1.14. Tank bottom drain valve

7.4.1.15. Tank top sampling device

7.4.1.16. Tank bottom sampling device

7.4.1.17. Skid base

7.4.1.18. Flat rollers

7.4.1.19. Insulating/cooling medium

7.4.1.20. Oil sealed silica-gel dehydrating breather.

7.4.1.21. Forced air cooling fan(s) and controls.

7.5. MV CABLE BOX:

- 7.5.1. The MV box shall be suitable for bottom entry and shall have facilities for access and termination of the cable specified. All materials necessary for the complete termination shall be provided with the transformer. Due to door restrictions, the MV box shall be installed once the main transformers are within the room. There is inadequate door height available to allow the transformers with the MV boxes enter the transformer rooms as one.

7.6. LV CABLE BOX:

- 7.6.1. The LV cable terminal box shall be suitable for bottom or top entry and shall have facilities for access and termination of the off loading arrangement specified. A full complement of compression type cable lugs and bolts shall be provided with each transformer. Due to door restrictions, the LV box shall be installed once the main transformers are within the room. There is inadequate door height available to allow the transformers with the LV boxes enter the transformer rooms as one.

7.7. EARTHING STUDS:

- 7.7.1. Earthing studs shall be provided on the undercarriage framework and shall be 13mm in diameter, 40mm long threaded over complete length, complete with 2 No. hexagon nuts, flat washers and shakeproof washers.

7.8. TAP CHANGER:

- 7.8.1. The off circuit tap changer shall be hand operated having five tap positions affording + or - 2.5% and + or - 5% about the principal tapping. The tap change mechanism shall be hand operated by means of an external activator with positive tap indicator and padlocking facilities at each tap position. Tap changers shall have provision for future paralleling requirements.

7.9. TESTING:

- 7.9.1. In addition to the routine tests specified in IS EN 60076, the following tests shall be undertaken on site by the transformer manufacturer:
- 7.9.1.1. Dielectric test in accordance with IS EN60076.
 - 7.9.1.2. Calibration and proving of all alarm/protection devices.
 - 7.9.1.3. Flash and crackle tests of insulating/cooling oil for conservator tank and main tank (where applicable).

7.9.2. Duplicate copies of the following shall be provided for the transformer on completion of commissioning:

7.9.2.1. All test results (type, routine and site tests).

7.9.2.2. Manufacturer's certified drawings.

7.9.2.3. Operating and maintenance instructions.

7.9.2.4. Technical specifications

7.9.2.5. Guarantees

7.9.3. Type tests shall be carried out and witnessed by the engineers, where specifically requested.

7.10. SYSTEM PARAMETERS:

The following system parameters apply unless specifically stated otherwise:-

Normal Voltage	:	20,000 / 10,000 volts (max. operating voltage at 20kV is 24kV)
Frequency	:	50 Hz
No. of Phases	:	3
Neutral Arrangement	:	Isolated from earth at 10kV/ resistance at 20kV
Fault Level	:	250 MVA

7.11. INSULATION LEVELS:

Impulse Level	:	125 kV (1.2/50 micro sec. wave)
Power Frequency Withstand Level	:	50 kV for 1 minute
Rated Short Time Current	:	12.5 kA for 1 sec.
Rated Peak Short Circuit Making Current	:	50 kA at 10kV / 32 kA at 20kV
*Rated Symmetrical Breaking Capacity of Circuit Breakers	:	12.5 kA at both operating voltages

7.12. PERFORMANCE AND DESIGN:

Voltage ratio at: no load	20,000/ 10,000 volts	400/230 volts
Tolerance on voltage ratio		0/5%
Connection	Delta	Star
Vector Group		DY11
Terminal markings from left to right observed viewing terminal box	U.V.W.	N.W.V.U.

8. 20/10 KV CABLES:

- 8.1. The 20/10 kV cable shall consist of XLPE/SWA cable screened with LSF oversheath and stranded copper conductors to IEC Standards, sized as indicated on the drawings.
- 8.2. The medium voltage terminals on the switchgear shall facilitate bottom/top cable entry.
- 8.3. The medium voltage cable shall be installed in floor ducts. The cable entry and exit shall be sealed against the ingress of moisture and vermin at each end.
- 8.4. The specialist supplier shall ensure that the 20/10 kV switchgear and transformer manufacturer are advised of the type and size of the 20/10 kV cable and provide suitable termination facilities. On-site modifications to cable boxes are totally unacceptable.
- 8.5. All 20/10 kV cable terminations shall be carried out in accordance with the cable manufacturer's instructions.
- 8.6. The following tests shall be carried out following the layout of the cables but before cable cores are connected to the equipment:
 - 8.6.1. Physical check and megger test for earth continuity and phasing.
 - 8.6.2. Insulation resistance between phase and phase to earth using 1 kV megger for one minute duration per test.
 - 8.6.3. High voltage DC pressure test of call cable conductors as follows:-
 - UVW to Earth - 25 kV for 15 minutes
 - U to V and W - 34 kV for 15 minutes
 - V to U and W - 34 kV for 15 minutes

9. TRANSFORMER LV CABLES:

- 9.1. The transformer LV cables from the transformer shall consist of 240 sq. mm single core NYN/XLPE / LSF cables with copper conductors installed in the floor trench, sizes as indicated on the drawings.
- 9.2. The LV cables shall enter the transformer LV cable box from the bottom and shall enter the LV switchboard from the bottom.
- 9.3. Each end of each core shall be clearly colour coded to identify phases.
- 9.4. Equal size neutrals shall be used.
- 9.5. A spaced trefoil cable arrangement shall be used.

10. PILOT TRIP AND ALARM CABLES:

- 10.1. The wiring system associated with the alarm and tripping installation shall be as indicated on the drawings. Particular attention is drawn to the need to clearly identify all cable cores and terminals in this area. The numbering system used will be subject to approval by the engineer.

11. EARTHING INSTALLATION:

- 11.1. The specialist supplier shall include for the complete earthing installation described hereunder.
- 11.2. The earthing installation shall be in accordance with the requirements outlined in the ETCI Regulations and the particular requirements of the supply authority.
- 11.3. The main earth bar shall comprise a 0.6m length of 50mm x 10 mm hard drawn high conductivity copper mounted on shock resistant insulators. The Main Earth bar shall be located in the LV Switchroom as shown on the drawings.
- 11.4. The following earth connections shall be made:-
 - 11.4.1. Main earth bar to frame of transformer.
 - 11.4.2. Main earth bar to frame of MV switchgear.
 - 11.4.3. Main earth bar to LV switchgear protective earth bar.
 - 11.4.4. Earth rods.

- 11.4.5. Steel building structure.
- 11.4.6. Incoming services
- 11.5. Links 11.4.1, 11.4.2 and 11.4.3 shall be effected by means of 252 sq mm high conductivity SLLPE/LSF cable with single core coppers installed in floor trench.
- 11.6. All main earthing connections shall be by means of 13 mm plated steel bolts, nuts and shakeproof washers.
- 11.7. The main earth terminal shall comprise two separate sets of copper earth electrodes (rods or plates depending upon the nature of the soil), driven vertically at least three metres underground outside at a distance of 4.5 metres from the buildings and three metres apart at each position. The rods shall be in 1.2 metres sections complete with phosphor bronze couplings, screws, hardened steel tips and steel driving caps. The rods shall be provided with a concrete surround for a fitted inspection cover.
- 11.8. The 95 sq. mm PVC earth lead shall be connected to each of the electrodes by means of a substantial and non-ferrous metal clamp to BS 951 which after inspection and tests by the Contractor in the presence of the Engineer shall be protected against corrosion with Denso tape.
- 11.9. The earth electrodes shall each be housed in an Armstrong junction or manhole with a removable access cover. The cover shall be heavy duty cast iron type, inscribed "M.V. EARTH - DO NOT REMOVE".
- 11.10. The resistance between any part of the M.V. earth system and the main earth electrodes shall not exceed 0.5 Ohms.
- 11.11. The total resistance to earth of the installation shall not exceed 5 Ohms.
- 11.12. The complete earthing installation shall be tested in accordance with the latest edition of the ETCI Regulations and in the presence of the Engineer before any voltage is applied to the system.
- 11.13. The specialist supplier shall include in his price for any additional earthing required by the local Supply Authority representatives.

12. ATTENDANCE ON THE SUPPLY AUTHORITY:

- 12.1. The Contractor shall include under this section for attendance on the Supply Authority during the installation of the Supply Authority MV switchgear and MV feeder cables. The Supply Authority will supply and connect the feeder from the Supply Authority MV switchboard.

13. TESTING AND COMMISSIONING:

- 13.1. The specialist supplier shall test all items of equipment individually and shall commission the full installation as a unified system.
- 13.2. All testing and commissioning shall be carried out in the presence of and to the satisfaction of the Engineer. The Contractor shall give fourteen days' notice in writing before testing or commissioning is carried out.
- 13.3. On completion of the testing and commissioning, four sets of records, bound in suitable folders shall be given to the Engineer. These records shall show all test results, relay settings, commissioning data, technical brochures, record drawings, etc., for the installation and all items of equipment.
- 13.4. All tests shall be carried out in accordance with the relevant IS Publication and those requested by the Supply Authority and shall include the individual tests specified for MV switchgear, 20/10 kV/1600 V transformers and 20/10 kV cabling.
- 13.5. All necessary equipment for carrying out these tests shall be provided by the specialist supplier.

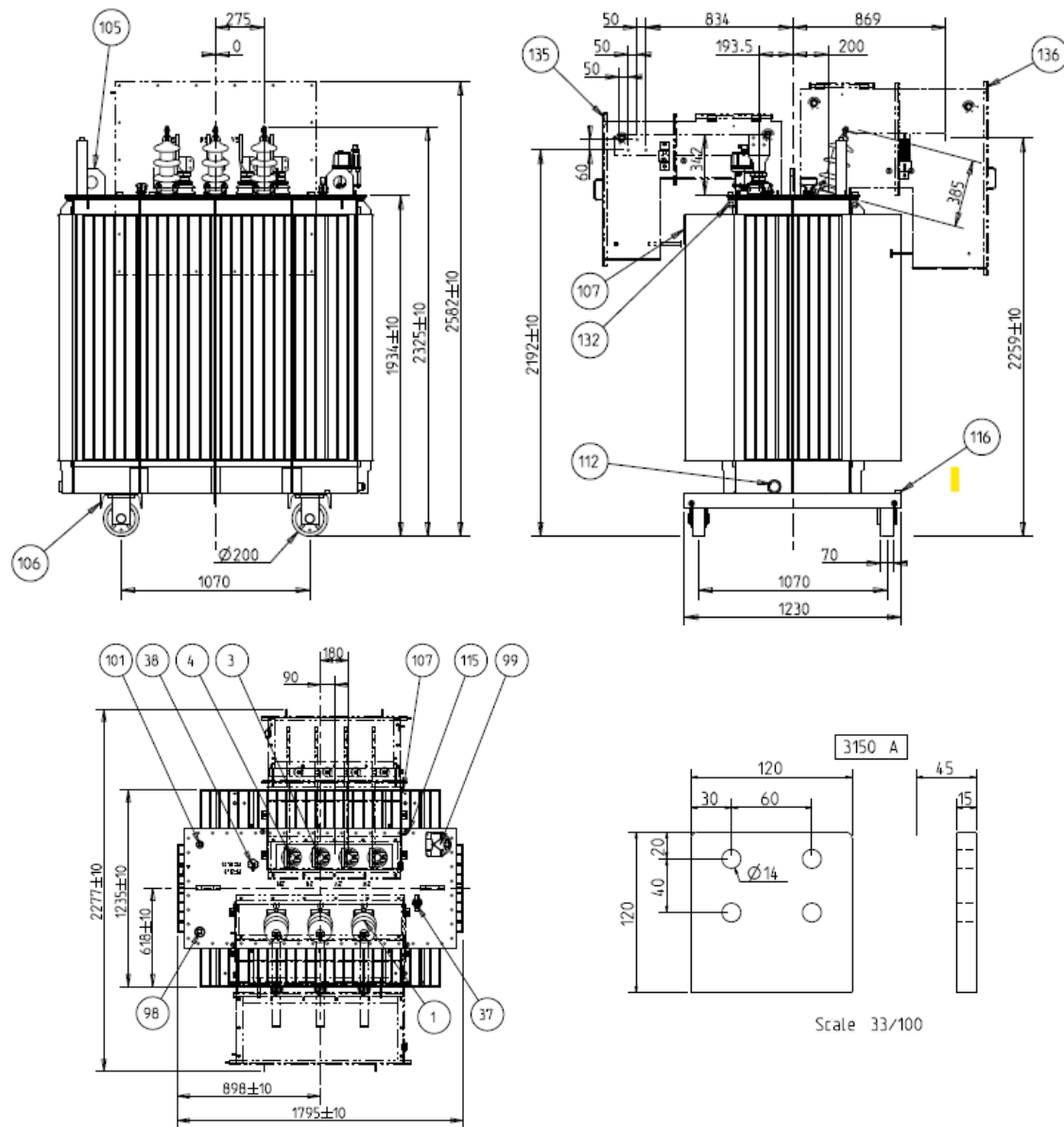
SCHEDULE 'A'

SCHEDULE OF PARTICULARS POWER DISTRIBUTION TRANSFORMER (OIL-FILLED)

1.	Transformer type	:	Hermetically Sealed	Conservator Type
2.	Insulating/cooling medium	:	0680-000 Mineral Oil IEC60296.	
3.	Rating	:	1600 kVA @	
4.	Service Conditions	:	Standard (IS EN 60076/1-5)	
5.	MV Cable - Size and Type	:	Refer to drawings for sizes and quantities.	
6.	Off loading Busduct/cable	:	Refer to drawings for sizes and quantities.	
7.	Accessories required		See specification	
8.	Details of connected loads		General Lighting and General Services Systems, Air Conditioning and Data Processing equipment, Clinical Imaging Equipment	
9.	Cooling	:	ONAN	ONAN
10.	Cooling Fans		Electric Driven Fans on internal temperature settings for Additional cooling of as Transformers are internal.	
11.	Vector Group		DY11N	

Note:

1. The MV cable box and LV cable box shall be fitted only when the two transformers are located within the transformer room. This is due to door restrictions.
2. The transformers must be Tier 2 units (Eco Directive).
3. Transformers shall be suitable for external environment.
4. Transformer to come complete with cooling fans.



- | | | | |
|-----|---|-----|-------------------------------|
| 1 | HV bushing 20Nf-30Ni/250A according DIN42531 | 107 | Rating plate |
| 3 | LV bushing 1/3150A according EN 50386 | 112 | Oil drain device A31 |
| 4 | LV bushing 1/3150A according EN 50386 | 115 | Earthing terminal M12 |
| 37 | Off circuit tapchanger | 115 | Earthing terminal M12 - Cover |
| 38 | Change over switch 21.5 / 10.75 kV | 116 | Earthing terminal M12 - Tank |
| 98 | Filling hole | 132 | Securing lugs |
| 99 | Device for temp-pressure-gas-oil level (DMCR) | 135 | LV Cable Box |
| 101 | Thermometer pocket | 136 | HV cable box |
| 105 | Lifting lug | | |
| 106 | Transport rollers | | |

APPENDIX 13

NEW OPW METERING SYSTEM

1. INTRODUCTION:

- 1.1. The Contractor shall include for the supply and installation of a complete OPW Metering System to monitor the MV Network, LV Network & Generator Standby systems in accordance with OPW specifications.
- 1.2. This specification covers the design, supply, delivery, installation, supervision, testing, commissioning, demonstration and all other works necessary for the OPW metering system in the implementation of a fully working OPW metering system complying in all respects with the requirements of the Engineer.
- 1.3. The system shall be supplied and installed by Power Point Engineering Ltd.

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Email: garrett@powerpoint.ie

- 1.4. The contractor shall include for the supply and installation of digital power meters within the switchboards. The digital power meter type to be installed within the switchboards shall be a Crompton Integra 1222 panel mounted unit.



- 1.5. The contractor shall include for the supply and installation of a OPW "Resource Craft" Panels to be installed within the OLB Switchroom and MDB2 Switchrooms (**2 Number panels**). The panels shall incorporate a GSM remote monitoring system for remote monitoring by OPW.

- 1.6. All meters shall also be wired back to the hospital BMS system via a new BMS outstation to be installed within the new OLB switchroom. All meters shall be wired in daisy chain format (no more than 8 number per circuit as per manufacturers recommendations) back to a set of terminals within the switchboard. From this location, the cables shall be wired to the BMS outstation.
- 1.7. All meters shall be wired back to the OPW system via the OPW "Resource Craft" Panel located in the new OLB switchroom, All meters shall be wired in daisy chain format (no more than 8 number per circuit as per manufacturers recommendations) back to a set of terminals within the switchboard. From this location, the cables shall be wired to the OPW "Resource Craft" panels.
- 1.8. The system shall be open protocol in accordance with EN standards.
- 1.9. All licenses associated hardware, software, components, programming, training etc. shall be included as part of the tender.
- 1.10. The system shall incorporate Type 1 & 2 surge protection.
- 1.11. The system is to be provided with full energy monitoring software.
- 1.12. The contractor shall provide a full warranty of the system.
- 1.13. Supply of all equipment and software licences required for the OPW System.
- 1.14. Supply of all interface devices required for the system.
- 1.15. Supply of protection devices required to protect all equipment against transient voltage surges.
- 1.16. Wiring including specified conduit and 24V AC Power equipment in accordance with all local and national codes and European Directives.
- 1.17. Configuration of all system equipment and software
- 1.18. Installation Commissioning
- 1.19. Client & Engineer demonstrations
- 1.20. Client training
- 1.21. All necessary testing
- 1.22. Operation & Maintenance Manual documentation and as-installed drawings
- 1.23. Programme modifications necessary to fine tune sequences during commissioning of all systems at no extra cost
- 1.24. Lead co-ordination regarding electrical requirements of all items of plant
- 1.25. Supply, offloading and installation of all necessary equipment.
- 1.26. The existing OPW metering system currently installed adjacent to existing main switchboard MDB2 shall be isolated, removed and disposed off-site once the new system is installed.

2. GENERAL:

- 2.1. The System shall consist of:-
 - 2.1.1. OPW Resource Craft Panels complete with GSM remote monitoring in compliance with OPW specification.
 - 2.1.2. Digital Power Meters.
 - 2.1.3. Pulse Splitters, chatter box e- isolation units, output split core current transformers, split core AC current sensors etc.
 - 2.1.4. Power and control wiring.
 - 2.1.5. Third party device integration.
 - 2.1.6. Upgradable and designed to grow as conditions and requirements change.
 - 2.1.7. Each panel shall come complete with 72-hour UPS back-up integral to the panels. In the event of mains failure, each panel shall be capable of remaining full operation via the UPS back-up system.
 - 2.1.8. Testing Commissioning, demonstration and training of the system.
- 2.2. The contractor shall include for the removal of the existing OPW metering system currently located within switchroom MDB2 and dispose of site.

3. CABLE SPECIFICATION:

3.1. TYPICAL CABLE SPECIFICATIONS:

3.1.1. SENSORS AND DIGITAL INPUTS:

- 3.1.1.1. 2 core (1 pair) shielded cables with stranded copper wire
- 3.1.1.2. Distances up to 500m: AWG 22 (0.5mm²) e.g. Belden 9414, 9462, 8671, 9461
- 3.1.1.3. Distances up to 1000m: AWG 18 (1.0mm²) e.g. Belden 8760, 9409
- 3.1.1.4. Minimum copper cross-section area: AWG 22 (0.5mm²)
- 3.1.1.5. Maximum copper cross-section area: AWG 14 (2.5mm²)
- 3.1.1.6. Recommended copper cross section area for PT1000 sensors: AWG 18 (1.0mm²)

3.1.2. RELAY OUTPUTS:

- 3.1.2.1. For mains rated relay contacts i.e. 230V @ 5A use stranded 1mm²

3.1.3. ANALOGUE AND DIGITAL OUTPUTS:

- 3.1.3.1. 2 core (1 pair) shielded or unshielded with stranded copper wire
- 3.1.3.2. Distances up to 500m: AWG 22 (0.5mm²) e.g. Belden 9407
- 3.1.3.3. Distances up to 1000m: AWG 18 (1.0mm²) e.g. Belden 8760, 9409, 8461
- 3.1.3.4. Minimum copper cross-section area: AWG 22 (0.5mm²)
- 3.1.3.5. Maximum copper cross-section area: AWG 14 (2.5mm²)
- 3.1.3.6. Recommended copper cross section area: AWG 18 (1.0mm²)

3.1.4. TWISTED PAIR ETHERNET NETWORK

- 3.1.4.1. Category 5e or Cat 6, 8 cores, 4 twisted pairs, unshielded or shielded, solid conductors, AWG 24
- 3.1.4.2. Maximum length 100m including patch cables
- 3.1.4.3. Unshielded cable types Belden 1583A, 7918A, 1700A
- 3.1.4.4. Shielded Ethernet cables must be installed by qualified engineers with Ground Loop avoidance training and shielded RJ45 connectors.
- 3.1.4.5. Shielded cables are only required in the event that the site is found to have high electrical noise.
- 3.1.4.6. Shielded cable type: Belden 7929A

3.1.5. FIBRE OPTIC ETHERNET NETWORK

- 3.1.5.1. 62.5/125 duplex fibre optic cable

3.1.6. CO-AXIAL ARCnet NETWORK

- 3.1.6.1. Co-axial cable with 93R impedance
- 3.1.6.2. Type RG62A/U

3.1.7. TWISTED PAIR ARCnet NETWORK

- 3.1.7.1. 2 core (1 pair) shielded, twisted pair, low capacitance cables with stranded copper wire
- 3.1.7.2. Minimum copper cross section area: AWG 24 (0.3mm²) e.g. Belden 9841 – distances less than 600 metres
- 3.1.7.3. Maximum copper cross section area: AWG 18 (1.0mm²) e.g. Belden 9841 – distances up to 1200 metres
- 3.1.7.4. Recommended copper cross section area: AWG 22 (0.5mm²) e.g. Belden 3105A

3.1.8. FIELDBUS

- 3.1.8.1. 2 core (1 pair) shielded, twisted pair, low capacitance cables with stranded copper wire
- 3.1.8.2. Minimum copper cross section area: AWG 24 (0.3mm²) e.g. Belden 9841 – distances less than 600 metres
- 3.1.8.3. Maximum copper cross section area: AWG 18 (1.0mm²) - distances up to 1200 metres
- 3.1.8.4. Recommended copper cross section area: AWG 22 (0.5mm²) e.g. Belden 3105A

3.2. MATERIALS AND CONSTRUCTION:

- 3.2.1. The panel enclosures shall be rigidly constructed from suitably prepared and finished best quality folded mild steel of a minimum thickness 2mm or of mild steel angle frame supporting sheets of a minimum thickness 1.2mm, or be a proprietary system of construction to the approval of the Engineer.
- 3.2.2. All panels shall be provided with hinged and lockable access doors or covers at the front of the panel and/or at the back of the panel as required to facilitate maintenance. Locks shall be cylinder type, provided with two keys each, and shall be identical for all panels.
- 3.2.3. Doors shall be flush-fitting mild steel with folded edges and welded corners of a minimum thickness of 2mm with concealed non-ferrous hinges, or of alternative construction to the approval of the Engineer. Framework associated with doors shall be fitted with skinned foam plastic dust protective strip or neoprene tube sealing gaskets.

- 3.2.4. Finished panels shall be without rough or sharp edges and shall present smooth surfaces. All exposed screws, bolts and similar fastenings shall be protectively plated.
- 3.2.5. Panels shall be finished externally with a full or semi-gloss stove-enamelled finish to BS colour of RAL 7032. All internal and external surfaces shall be properly prepared before final finishing.
- 3.2.6. Panels secured to a finished floor shall be provided with a metal plinth. A metal plinth is not required with panels mounted on a raised builders work SCADAe. All panels shall be provided with fixing holes. Large panels or panels exceeding 75kg shall be provided with detachable lifting eyes.
- 3.2.7. Heat generating devices such as starters, transformers, relays, etc. shall be mounted on a DIN rail with adequate spacing between each unit to allow for heat dissipation. End stops shall be provided on DIN rail mounted equipment as necessary to prevent movement.
- 3.2.8. Panel wiring for electronic thermostatic and humidity control sensors, and for any other items as necessary, shall be in screened multicore flexible cable. Extra low voltage wiring and connections shall be segregated from those for higher voltage or be insulated for the highest voltage present. Starter auxiliary contacts shall be volt-free.
- 3.2.9. Fuses shall comply with the requirements of BS 88 and shall be grouped and mounted so as to be readily and safely accessible.
- 3.2.10. Grouped terminal blocks of adequate size and capacity shall be provided for all cables leading to equipment outside the panel. A removable cover, or other facility such as a removable blank flat gland plate, shall be provided for the entry of incoming cables, conduits, trunking, etc. with means for effective electrical bonding to the panel.
- 3.2.11. The control circuitry within panels shall be arranged such that each control system is separately protected. For the purpose of this clause, a 'control system' shall be defined as that necessary to sustain an item of plant and/or control a zone. Stand-by plant shall have separately fused supplies.
- 3.2.12. Provision shall be made for the earthing of all non-current carrying panel and equipment metalwork including panel doors. All necessary electrical bonding shall be provided together with an earthing terminal of adequate size, positioned within the panel at the rear or bottom on a part which is not removable. Access shall be provided for making connections to the earthing system.
- 3.2.13. All control circuits wiring shall be numbered to assist fault finding and manufacturer. These numbers to be recorded on the "As Constructed" panel drawing.

3.3. IDENTIFICATION LABELS:

- 3.3.1. Fuses, terminal blocks and all other items of equipment within panels shall be suitably identified by means of clearly inscribed labels of a permanent nature attached or adjacent to them. All items on the outer surfaces of panels shall be identified with laminated plastic labels engraved white/black/white and shall be fixed with screws or rivets. The full requirements of IS EN 60439-1 shall be provided.

3.4. VENTILATION:

- 3.4.1. The temperature rise in panels shall not exceed the limits stated in IS EN 60439-1. Where automatic control items are installed, panel construction shall provide adequate ventilation for internal heat dissipation. Provisions shall be made to ensure that the internal temperature is limited to 10°C above ambient.

3.5. INSTRUMENTS AND INDICATION:

- 3.5.1. All indicating lamps, instruments and controls shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and facilitate maintenance. Externally visible equipment shall be flush-mounted and fixed securely to the faces of control panels. Internal equipment shall be fixed to purpose-made rails or mounting bars. All fixings shall incorporate shake-proof washers or other vibration resistant fastenings.
- 3.5.2. The colours and colour significance of indicator lamps shall be in accordance with IS EN 60073, unless otherwise indicated. Where extra low voltage filament lamps are installed, they shall be fed from a double-wound transformer complying with BS 3535. Permanent legible information shall be provided adjacent to each indicator lamp to readily identify its function.
- 3.5.3. Where indicated, facilities shall be provided within the panel for remote alarm and fault indication. A lamp test facility shall be provided on all panels having four or more indicator lamps.
- 3.5.4. Indicator lamps and instrumentation shall function with selector switches in the 'HAND' or 'AUTO' position.

4. TESTING AND COMMISSIONING:

4.1. GENERAL:

- 4.1.1. The Contractor shall provide all test equipment and hand-held radio transmitters as required for all stages of testing, commissioning and demonstration. Recent calibration certificates must be provided for all test equipment used. The Engineer may be present to witness all testing.

4.2. FINAL WIRING CONNECTIONS:

- 4.2.1. The Contractor shall be responsible for checking all automatic control system wiring and making-off of final connections at outstations, user-interfaces, panels, field controllers and control devices. All cables to be glanded, stripped and each core prepared for inserting in terminal, tested and clearly labelled by the electrical contractor prior to final termination by the Contractor.
- 4.2.2. All screened cables shall be earthed at the control panel only; at the field device the screen shall be cut back and insulated.

4.3. PRE-COMMISSIONING/TESTING:

- 4.3.1. The Contractor shall be responsible for pre-commissioning and testing. At pre-commissioning stage, the SCADA Contractor shall examine all automatic control systems wiring and connections on the system in order to ensure that no damage will occur to any equipment whether provided by the Contractor or not.
- 4.3.2. The exact method of testing shall be the responsibility of the Contractor.
- 4.3.3. The Contractor shall supply signed test sheets for all equipment connected to the system. These sheets shall clearly indicate and sign-off on each of the following headings:-
 - 4.3.3.1. Equipment Selection
 - 4.3.3.2. Installation
 - 4.3.3.3. Termination
 - 4.3.3.4. Function
 - 4.3.3.5. Calibration
 - 4.3.3.6. Correct Operation

4.4. INPUT/OUTPUT TESTING:

- 4.4.1. The Contractor shall arrange the operation or simulated operation of all plant, equipment and controls devices and verify the controls signal at the user interface. This procedure shall be witnessed by the Engineer. The Contractor shall supply signed sheets for these tests.

4.5. OPERATIONAL TESTING:

- 4.5.1. After completion of pre-commissioning/testing and input/output testing, each sub-system shall be fully tested to ensure correct operation as per the approved control strategy.
- 4.5.2. The Contractor shall revisit the site after handover and allow for 1 week to check and adjust the parameters for control to optimise settings.

4.6. ACCEPTANCE DEMONSTRATIONS:

- 4.6.1. The Contractor shall demonstrate the following in the presence of the Client and the Engineer:-

4.6.1.1. FIELD EQUIPMENT DEMONSTRATION

- 4.6.1.1.1. Automatic control operation shall be verified by introducing an error into the system and observing the proper corrective system response.
- 4.6.1.1.2. Selected time and setpoint schedules shall be verified by changing the schedule and observing the correct response on the controlled outputs.
- 4.6.1.1.3. An output channel will be commanded (on/off, stop/start, adjust, etc.) and operation verified.
- 4.6.1.1.4. An analog input channel will be verified by changing the state of the field device and observing the appropriate change of displayed value.
- 4.6.1.1.5. A digital input channel will be verified by changing the state of the field device and observing the appropriate change of displayed value.
- 4.6.1.1.6. Typical occupancy control device function shall be demonstrated.
- 4.6.1.1.7. If a point should fail testing, perform necessary repair action and retest failed point and all interlocked points.

4.6.2. WORKSTATION DEMONSTRATION

- 4.6.2.1. Communication with typical main plant and ASC controllers shall be demonstrated
- 4.6.2.2. Operator commands shall be explained and demonstrated
- 4.6.2.3. Selected control sequences shall be demonstrated for proper operation
- 4.6.2.4. Review of time schedules and alarm priorities
- 4.6.2.5. Selected system reports and logs shall be demonstrated at the system workstation
- 4.6.2.6. Correct system start-up and shutdown procedures shall be demonstrated
- 4.6.2.7. Selected controllers shall be demonstrated to operate in standalone mode

5. SYSTEM HANDOVER

5.1. The Contractor shall ensure the following are completed at handover stage:-

- 5.1.1. Any issues requiring corrective actions to be documented and agreed dat determined for clearance
 - 5.1.1.1. All access levels and passwords recorded and backed up
 - 5.1.1.2. Consumables, printer ribbons, printer paper as agreed with the Client
 - 5.1.1.3. All keys necessary for access to panels and equipment to be presented to the Client.
 - 5.1.1.4. Recommended spare parts list and contact details for all suppliers
 - 5.1.1.5. Operating and maintenance cautions and instructions
 - 5.1.1.6. Unless otherwise indicated, the SCADA Contractor shall allow 2 days formal training for 3 people, over a time span of two weeks, and shall provide all necessary items (e.g. hardware, software, consumables, etc.) to accomplish this.

6. OPERATOR TRAINING

- 6.1. The Contractor shall provide detailed on-site and off-site training to selected client staff. Training shall be carried out separately for both engineering and operator staff. Factory trained control engineers and technicians shall provide training sessions for the clients personnel.
- 6.1.1. Training shall include:-
- 6.1.1.1. Explanation of drawings, operations and maintenance manuals
 - 6.1.1.2. Overview of the system
 - 6.1.1.3. Walk-through of project to locate control components
 - 6.1.1.4. Operator workstation and peripherals
 - 6.1.1.5. Operation of portable operators workstation including any wireless equipment
 - 6.1.1.6. Use of occupancy controls
 - 6.1.1.7. Use of keypad/display devices with customised menus
 - 6.1.1.8. Use of overrides and passwords
 - 6.1.1.9. Use of data logs, time schedules and alarms handling
 - 6.1.1.10. Communication Controllers, DDC Controllers, ASC operation/function
 - 6.1.1.11. Operator control functions including graphic generation and field panel programming
 - 6.1.1.12. Explanation of adjustment, tuning, calibration and replacement procedures.
- 6.1.2. The Client may require their personnel to have more comprehensive training of the hardware and software and this must be available from the Contractor. If such training is required, it shall be contracted at a later date. The SCADA Contractor shall provide a description of available local and factory SCADA Client training.

7. RECORD DOCUMENTATION:

- 7.1. Refer to appendix 1.
- 7.2. The preparation, completion and issue of record documentation by the contractor shall comply with Part 3.15 of this Specification.
- 7.3. Controls systems record documentation shall include, but is not limited to, the following:-
 - 7.3.1. Two copies of all system and data SCADAe files supplied on CD with appropriate identification
 - 7.3.2. An Operator Reference Table, listing the addresses of all connected points. Settings shall be shown where applicable
 - 7.3.3. System drawings matching the installed networks, equipment and peripheral connections
 - 7.3.4. Flow charts of the control software programs utilised in the temperature control system
 - 7.3.5. Recommended spare parts list and contact details for all suppliers
 - 7.3.6. Operating and maintenance cautions and instructions
 - 7.3.7. Commissioning test sheets
 - 7.3.8. Control points list
 - 7.3.9. As-commissioned drawings
 - 7.3.10. Equipment data sheets
 - 7.3.11. System operational description
 - 7.3.12. Setting sheets
 - 7.3.13. Maintenance proposal
 - 7.3.14. Completion certificate
 - 7.3.15. Test equipment calibration certificate
 - 7.3.16. Control panel factory test certificate



Energy and Water Saving Solutions

PULSE SPLITTER

Split Meter Pulses Up To 3 Loggers

Enica Pulse Splitters are the convenient way of splitting meter pulse outputs up to 3 separate loggers or telemetry systems.

INPUT/OUTPUT CONNECTIONS

- Pulse Input
- Up to 3 pulse loggers output

EASY TO INSTALL

The Standard Pulse Splitter has simple screw terminals located inside the enclosure to allow easy wiring of pulse equipment. DIN rail versions make for simple installation within control panels.

WATERPROOF VERSION

The waterproof pulse splitter benefits from a completely encapsulated enclosure meaning it could be regarded as waterproof to IP68 standard.

NO POWER SUPPLY REQUIRED

Enica pulse splitters are completely passive devices, meaning there are no batteries. The device is powered from the attached loggers.

STAINLESS STEEL BRACKET

To avoid messy wiring installations, the waterproof pulse splitter comes with a stainless steel mounting bracket for use within a water meter pit.

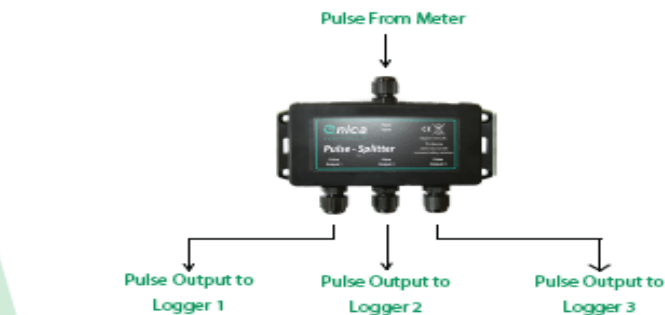
STANDARD AND DIN RAIL SPLITTER TECHNICAL SPECIFICATION

No. of Inputs (Pulse).....	1
Pulse Types.....	Open Collector or Reed
No. of Outputs (Pulse).....	up to 3
Min Voltage (Logger).....	1.2V
Max Voltage (Logger).....	24V
Mass.....	approx 0.1kg
Power Supply.....	None (Passive Device)

WATERPROOF SPLITTER TECHNICAL SPECIFICATION

No. of Inputs (Pulse).....	1
Pulse Types.....	Open Collector or Reed
No. of Outputs (Pulse).....	up to 3
Min Voltage (Logger).....	1.2V
Max Voltage (Logger).....	24V
Cable lengths.....	750mm each
Mass.....	approx 0.25kg
Power Supply.....	None (Passive Device)

Owing to periodical improvements of our products the supplied products can differ in some details from the data stated in the prospectus material.



© Copyright



Standard Pulse Splitter



Waterproof Pulse Splitter



DIN Rail Pulse Splitter



Energy and Water Saving Solutions

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Jan 2014

GE Oil & Gas

Dresser* Chatterbox-e Isolation Unit

Model 103 Opto-Isolation Unit



The Dresser Chatterbox-e Isolation Unit provides the necessary safety isolation between equipment generating pulses in a hazardous area and non intrinsically safe equipment located in a safe area.

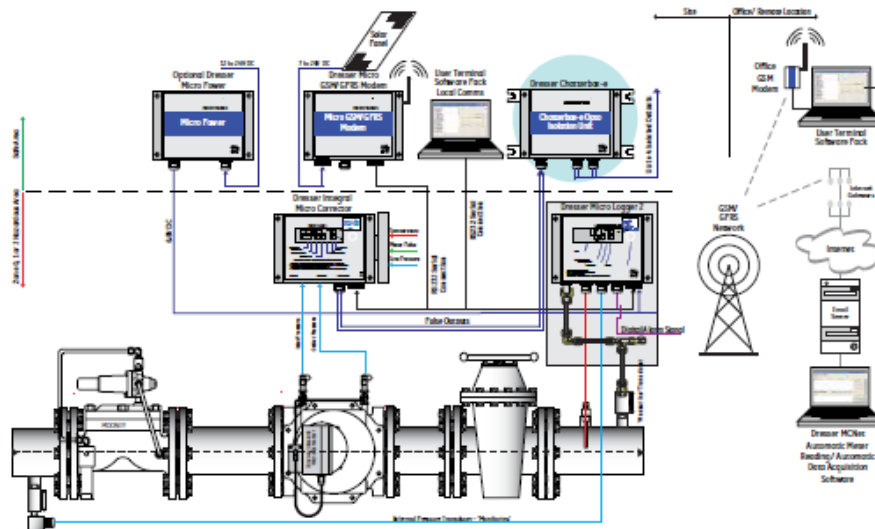
Opto - isolators provide four isolated volt-free contacts from low frequency pulses generated by gas meters or volume correctors installed in a hazardous area.

The Chatterbox-e Isolation Unit operates from a self-contained power supply lasting in excess of 10 years and is suitable for installation in remote and rugged environments without the need for an external power supply.

The unit consists of four independent circuits that transform high impedance pulses, or volt-free contact closures into isolated volt-free contact closures. One input can be connected to up to four isolated output circuits by using internal switches.

- 10 Year battery life from standard cells; two 1/2 AA lithium. "Virtual power for life"
- Four channels as standard
- Channel selections via switches
- Two output glands as standard promotes ease of installation when more than one system is to be connected to the Chatterbox-e
- ATEX Certified Intrinsic Safety
- Weatherproof cast aluminum housing rated to IP66 (equivalent to NEMA 4x) offers flexibility of installation
- Compliance to UK Institute of Gas Engineers Editions 1 & 2 "Electrical Connections to Gas Meters" and USA Article 500 of the National Electrical Code, ANSI/NFPA-70 (NEC)"
- Opto-isolation increases reliability and reduces power consumption
- Simple mechanical and electrical installation
- Single or multiple outputs from single input
- No corrector or meter setting required. As soon as the Chatterbox-e receives a pulse, a 220ms isolated output pulse is generated





Inputs

Each input is designed to interface with the current 'sinking' pulse outputs from the Dresser Micro Corrector. The input will also interface directly with a volt-free contact closure, i.e., directly to a gas meter. Contact debouncing as standard.

Outputs

Each output is a 220ms pulse, current sinking output capable of accepting up to 20V, 130mA.

Enclosure

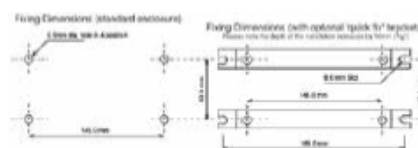
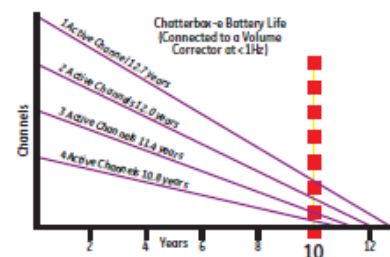
Weatherproof aluminum enclosure IP66 (equivalent to: NEMA 4x) rated suitable for wall or panel mounting. Size: 160mm wide x 120mm high over glands x 62mm deep.

INTRINSIC SAFETY BASEEFA
03ATEX0429 II (1)G [EEx ia] IIC

The Chatterbox-e must be installed in a safe area and is suitable for connection to equipment in hazardous areas Zone 0, 1 or 2.

Power Supply

Two 1/2AA lithium cells giving an estimated life in excess of 10 years based on all four channels operating and an input frequency of <1 Hz from a volume converter.



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GEA19944A Dresser Chatterbox-e Isolation Unit
11 2012

0.333V OUTPUT SPLIT CORE CURRENT TRANSFORMERS

HOBUT

DESCRIPTION

The new range of mV split core current transformers is designed to fit into confined spaces whilst the primary conductor is still live. The family of CT's are compact design with a mechanical hinge for multiple opening and closing action.

APPLICATION

For connection into existing networks. Often for use with multifunction meters that have 0.333V input.



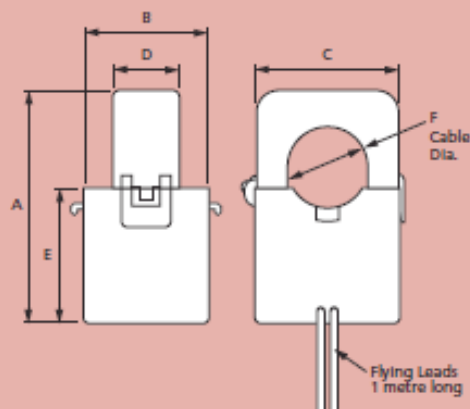
FEATURES

- High Sensitivity
- Class 1 accuracy
- Linearity with minimum phase shift
- 0.333V AC secondary output at rated current
- Mechanical hinge

TECHNICAL SPECIFICATION

- Input frequency 50 to 400Hz
- Maximum primary voltage 720V AC
- Dielectric withstand voltage 2.5Kv for 1 minute
- Operating temperature -15C to +50C
- 1 metre long flying lead twisted pair (22AWG)
- Construction – Ferrite core material
- Case nylon UL flame retardent rating 94V-0

DIMENSIONS (mm)



RANGE

CURRENT RATING	PART No.
30A	CTSCMWH30/0.333V
60A	CTSCMWH60/0.333V
120A	CTSCMWH120/0.333V
250A	CTSCMWH250/0.333V
500A	CTSCMWH500/0.333V

DIMENSIONS (mm)

A	B	C	D	E	F
41.7	26.4	28.7	15.0	25.3	10
41.7	26.4	28.7	15.0	25.3	10
53.0	31.0	29.9	18.2	32.0	16
69.6	38.6	43.5	20.4	41.0	24
83.5	51.2	51.2	26.1	60.0	35

Our policy is one of continuous development and therefore specifications may change without notice.

HOWARD BUTLER LTD

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<http://www.hobut.co.uk>

January 2014

MAGNELAB

Split-Core AC Current Sensor SCT-2000

2.00" Opening With Ratings Up To 1500 Amps

Description:

Magnelab's SCT-2000 Series split-core current sensors "sense" AC current up to 1500 Amps passing through the center conductor. Split-core transformers are ideal for installation on existing electrical wiring by snapping around the conductor. The SCT series have a self-locking mechanism. Custom outputs and other parameters available at customer request.



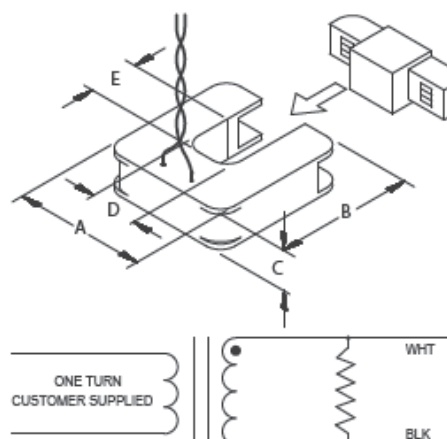
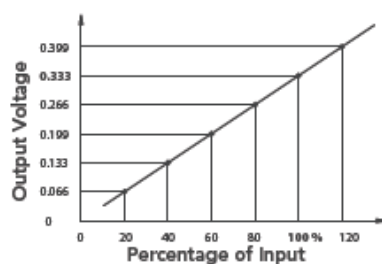
Features:

- Rated input up to 1500 Amp
- Output of 0.333 Volt at rated current
- Linearity accuracy $\pm 1\%$
- Accuracy at 10% to 130% of rated current
- Phase angle < 2 degrees measured at 50% rated current
- Operates from 50 Hz to 400 Hz
- 8 ft. twisted-pair lead
- UL recognized, CE, and RoHS compliant

PART NUMBER AND RATING	
SCT-2000-000	No Burden Resistor*
SCT-2000-100	100 Amp
SCT-2000-200	200 Amp
SCT-2000-400	400 Amp
SCT-2000-600	600 Amp
SCT-2000-800	800 Amp
SCT-2000-1000	1000 Amp
SCT-2000-1200	1200 Amp
SCT-2000-1500	1500 Amp

* Zener diode limits the output voltage to 22 V

DIMENSION	INCH	MM
A	4.750	120.65
B	5.000	127.00
C	1.200	30.48
D	2.000	50.80
E	2.000	50.80



CE RoHS ISO 9100:2000

Rev. B

Magnelab.com

U.I. Lapp GmbH	PRODUCT INFORMATION	 LAPP GROUP
	UNITRONIC® LIYCY	19.11.2014

Screened data transmission cable with colour code acc. to DIN 47100
 Overall braid minimises electrical interference
 Multifunctional application possibilities



Interference signals

Application range

Screened cables with small dimensions are suitable for use in computer systems, instrumentation technology, office equipment, balances.
 Dry or damp rooms

Product Make-up

Fine-wire/multi-wire (0.34 mm²) strand made of bare copper wires
 Core insulation made of PVC
 Tinned-copper braiding
 Outer sheath made of PVC
 Outer sheath colour: pebble grey (RAL 7032)

Norm references / Approvals

Based on VDE 0812

Product features

Flame-retardant according IEC 60332-1-2

Remark

Unless specified otherwise, the shown product values are nominal values. Detailed values (e.g. tolerances) are available upon request.

Copper price basis: EUR 150/100 kg. Refer to catalogue appendix T17 for the definition and calculation of copper-related surcharges.

Please find our standard lengths at: www.lappkabel.de/en/cable-standardlengths

Packaging size: coil ≤ 30 kg or ≤ 250 m, otherwise drum

Please specify the preferred type of packaging (e.g. 1 x 500 m drum or 5 x 100 m coils).

Photographs are not to scale and do not represent detailed images of the respective products.

Product Management	Document: LAPP_PRO217EN.pdf	1 / 6
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PN 0486/01_03.10

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 Photographs are not to scale and do not represent detailed images of the respective products.

APPENDIX 14

PROTECTIVE CLOTHING & EQUIPMENT SPECIFICATION

1. INTRODUCTION:

- 1.1. The Contractor shall include for the supply and installation of a complete set of protective clothing and equipment as part of the contract.
- 1.2. All equipment shall be installed within the sub-station in accordance with manufacturers recommendations. All equipment shall be handed over to the client as part of practical completion.
- 1.3. The clothing & equipment shall be supplied and installed by Power Point Engineering Ltd.

Mr Garrett Kelly
 Tel: +353 (0)57 8662162
 Mob: +353 (0) 87 2318202
 Email: garrett@powerpoint.ie

2. SPECIFICATION:

- 2.1. The clothing & equipment specification and quantities are identified on the table below..
- 2.2. The contractor shall include for the supply and installation of all items and quantities identified in the tables below etc as part of the contract.

Product No.	Product Description		Qty.
SS-ERB-LV	Electrical Rescue Kit • CPR Sign • SGP Glove Storage Box • SG-50 T10 Class 0 Sofamel Dielectric Gloves • F/G Rod and Phase Check LV Detector • DEK3-H-1 Class 3 Insulating Matting - working voltage up to 26kV • Sofamel BS-45 Rescue Pole 1.75 m 45kV and brackets		1
SS-ERB-MV	• CPR Sign • SGP Glove Storage Box • SG-30 T10 Class 3 Sofamel Dielectric Gloves • F/G Rod and Phase Check LV Detector		1

	- VTO-5/36-P Sofamel Analogic MV Detector with Operating Pole - Sofamel BS-45 Rescue Pole 1.75 m 45kV and brackets		
505110	Insulated 4 Rung Step Ladder	EN 131 UNE-EN 50528 UNE-EN 61478, electrical insulation tested between rungs - 100 kV	1
ST-45	45kV Class 5 Insulating Stool	UNE 204001	1
BS-45	1.79m Rescue Pole 45kV c/w mounting brackets		1
DEK3-H-1	Class 3 Insulating Matting 23kV (10m Rolls)	IEC 61111	3
SG-30-T10	Class 3 Dielectric Gloves (Size 10)	IEC 60903 EN 60903	2
545111	Plastic Glove Case		2
5PJ7-L-SH-G	Survive Arc 51cal Switching Suit Non Vented LARGE	NFPA 70E SANS 724 IEC 61482-2 CE 0339	1
5PJ7-M-SH-G	Survive Arc 51cal Switching Suit Non Vented LARGE	NFPA 70E SANS 724 IEC 61482-2 CE 0339	1
VTO-5/36-P	Analogic MV Voltage Detector Rated voltage: from 5 to 36 kV Frequency: 50 / 60 Hz Insulating pole: 1.30 m (included) Supplied with carrying bag for pole and metallic box to store and transport the voltage detector		1
PATC-MPL-9595	Earthing Kit 25kA 1s c/w case and operating rod.		1
	Hanron Phase Check Voltage Detector		1

3. OPERATOR TRAINING:

- 3.1. The Contractor shall provide detailed on-site training of all safety equipment to selected client staff. Training shall be carried out separately for both engineering and operator staff. The contractor shall allow for 2 days of training (2 1 days for training of two groups).

APPENDIX 15

FIRE EXTINGUISHERS SCHEDULE

1. FIRE EXTINGUISHERS SCHEDULE

- 1.1. The contractor shall include for the supply & installation of Fire Extinguishers as part of the contract.
- 1.2. The hand held fire fighting extinguishers and ancillary components as detailed below, shall be provided under the contract. 1 of each extinguisher shall be installed within the MV room, LV Room and transformer rooms.
 - 2kg CO2 fire extinguishers with brackets
 - 5kg CO2 fire extinguishers with brackets
 - 6kg powder type fire extinguishers c/w wall fixing
 - ID signs ONE PER EXTINGUISHER
 - Fire point signs ONE PER EXTINGUISHER

NOTES:

1. All fire extinguishers shall conform to BS EN 3: 2006, BS 7863 and BS 5306-8: 2000.
2. All fire extinguishers (excluding the Co2 extinguishers) shall be manufactured from stainless steel and powder coated.
3. All CO fire extinguishers shall be manufactured from aluminium and powder coated.
4. Each extinguisher shall be provided complete with a brass chrome plated valve, high visible pressure indicator and protective plastic base.
5. All fire extinguishers shall be provided complete with captive nut head.
6. The contractor shall include for mounting the fire extinguishers in locations to be agreed with the engineer on site. All extinguishers to mounted in accordance with IS 290 and IS 291
7. This schedule must be read in conjunction with the relevant part of the Specification.