

07 – Electrical Services

Version	Date	Authors	Summary of Changes
1.0	29 February 2012	Jim Pollard	See V1 summary below
2.0	05 February 2016	Neill Daly	General Revision
2.1	9 February 2021	Sarah O’Callaghan	General Revision
2.2	10 July 2023	Shoaib Shah	Updated
2.3	15 January 2024	Shoaib Shah	Updated

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07.01.

Preamble

07.01. This document contains the Electrical Design Guide, a section of the Campus and Building Requirements Manual (the CBRM, the Requirements or the Manual) which briefly describes the design objectives for the Australian National University (the ANU or the University) electrical installations.

07.02. A separate electrical specification which establishes a base level of quality for ANU electrical installations is available and is to be integrated in all designs, titled the ANU General Electrical Specification.

07.03. The ANU is committed to energy efficient design and long-term, low maintenance costs. Consultants shall familiarise themselves with the existing services and systems on the campus' on which they may be involved with prior to the commencement of feasibility and planning.

Introduction

Campus and Building Requirement Manual

07.04. The CBRM documents the minimum design and construction requirements for new, refurbishment or repurposed building works, landscapes and engineering/infrastructure projects on buildings, facilities and campuses of the ANU. The Requirements are prepared for the direction of a Consultant, Designer or Project Manager in the preparation of project specific documentation and in the delivery of project works.

07.05. Notwithstanding any Consultant's particular discipline or area of responsibility, each Consultant and/or designer shall consider the document in its entirety. The complete CBRM consists of the following Sections which may be referred to within this Section:

Campus and Building Requirements Manual	
Section 01	General Requirements
Section 02	Architectural Requirements
Section 03	Roads, Car Parking & Civil Works
Section 04	Soft Landscaping
Section 05	Roofing, Roof Fabric & Roof Safety
Section 06	Building Management Systems
Section 07	Electrical Services
Section 08	Fire Protection Systems
Section 09	Hydraulic Systems
Section 10	Mechanical Services
Section 11	Lifts, Cranes & Vertical Transportation Systems
Section 12	Security, CCTV & Access Control
Section 13	PV Systems

Scope

07.06. This section of the CBRM addresses the following electrical services:

Inclusions

- Liaison with electrical supply authorities
- High voltage where applicable

- Power supplies, consumers mains and sub mains
- Earthing
- Electrical safety
- Switchboards
- General light and power
- Lighting and lighting controls
- Emergency lighting
- Metering and energy management
- Electrical “green” initiatives
- Emergency back-up power and UPS equipment
- Variable speed drives
- Electro-magnetic compatibility (EMC) compliance
- Power factor correction (PFC)
- Lightning and surge protection

Exclusions

- Emergency warning and communication systems
- Datacoms
- Fire alarms
- Electronic security and access control
- CCTV
- Audio visual systems

Electrical Design Guide

Overview

07.07. The Facilities and Services Division (F&S or the Division) is required to maintain an overview of the electrical services installed on all campuses, buildings, structures and facilities owned and managed by the ANU in the various states and localities of Australia.

07.08. Consultants, Designers or Project Managers who are engaged by the ANU to produce project documentation may use the ANU General Electrical Specification if appropriate or alternatively provide a project specific electrical specification incorporating all the ANU’s requirements as identified in the CBRM.

Standards and Codes

07.09. For all new facilities, particular attention shall be paid to the design and selection of appropriate electrical plant, equipment and systems which shall be tested,

commissioned, maintained and serviced in accordance with relevant Codes and Standards. Reference shall also be made to the latest issue of relevant Australian Standards, Codes of Practice, Local Authority regulations, Acts and the like. If there is no relevant Australian Standard then reference shall be made to ISO/BS/ANSI/ASTM standards.

07.010. For electrical services associated with buildings under refurbishment, the plant and equipment (where replaced) will be selected to meet the optimum design performance parameters. The Consultant will determine whether compliance with the National Construction Code (NCC), and specifically the energy efficiency requirements of Section J of the NCC, in full or part is required. The Codes and Standards to be followed will be as for plant in new buildings.

The Sites - Electrical Reticulation

07.011. Acton campus, Canberra ACT: Expansion of the Acton campus beyond its original site boundary has resulted in multiple electrical connection/disconnection points provided by the supply authority, Evoenergy.

07.012. A large portion of the Acton campus is serviced from a network of interconnected 11 kV ring mains and 11kV/400V/230V 50 Hz substations originating from two bulk supply substations and back-up connections located on the campus boundaries. There are approximately 50 sole-use substations located on the campus. A single, high voltage monthly invoice is received by the ANU for all the energy consumed by these substations. The ANU Acton campus HV network is owned and maintained by the local supply authority, Evoenergy.

07.013. Most of the HV reticulation is by underground cable but there are remnants of supply authority HV aerials. Note that there is also a section of ANU privately-owned HV equipment (used in scientific experiments) located at the Research School of Physics.

07.014. ANU acquisitions such as the School of Music and the School of Art are not on the ANU HV grid and are supplied via district substations. Similarly more recent acquisitions such as Unilodge and Student Accommodation 4 (SA4) are supplied from district substations. These facilities receive individual billing from the Electricity Retailer.

07.015. ANU staff and contractors CANNOT access HV equipment and substations without prior approval from Evoenergy.

07.016. Small off-site facilities such as North Oval take power from the local aerial reticulation.

07.017. Paleomagnetic Laboratory, Black Mountain ACT: Low voltage aerials are provided by the supply authority to an ANU point of attachment pole and meter box located at the ANU's site boundary.

07.018. Mt Stromlo campus, Canberra ACT: The RSAA Mt Stromlo facility takes LV power from a number of district substations and receives multiple electricity consumption invoices from the Electricity Retailer. There are also some commercial/government facilities on the Mt Stromlo site not connected with the ANU that are also serviced by the local supply authority. All HV aerials and substations are owned and maintained by the supply authority.

07.019. Siding Spring Observatory (SSO), Coonabarabran NSW: The SSO facility takes power from two district substations and receives multiple electricity invoices from the Electricity Retailer. All HV aerials and substations on the SSO site are owned and maintained by the supply authority.

07.020. Other Sites: Refer to the Principal's Representative (the Principal or the Principal's Project Manager) for details

Building Controls and Monitoring

07.021. Refer to [Section.06 Building Management Systems](#).

Emergency Electrical Supplies and Uninterrupted Power Supplies

07.022. The ANU has a large number of emergency power generator plants and Uninterrupted Power Supply (UPS) systems across the various operations. Emergency power and UPS provisions shall be discussed with the Principal's Representative as early as practical in the planning stage.

07.023. Generator control systems shall be provided with a HLI to the BMS to facilitate demand response.

Emergency Alarm and Communication Systems

07.024. [Refer to Section.08 Fire Protection Systems](#).

Loading

07.025. Any proposed alterations to the electrical loads on a site shall be discussed with the Principal's Representative at the earliest opportunity. The Division has information on site loads and has equipment to do load measurements. It is important that the local reticulation has evenly balanced phases.

Metering

07.026. As the ANU has a number of facilities located across various states, regional areas and local authorities, the metering requirements will need to be specifically tailored on a project by project basis. Accordingly, early discussion is necessary with the Principal's Representative to confirm project requirements.

Refer to the **electrical metering specification** for further details.

07.027. The metering needs at the ANU will meet two basic requirements being:

- Cost recovery; and
- energy management and energy monitoring.

07.028. The ANU is committed to continuing improvements in energy efficiency and requires accurate energy consumption data to manage individual operations. The strategic direction is that sub meters shall be deployed. The minimum level of energy management metering required is as identified in the NCC. Where appropriate the ANU may wish to go beyond the NCC and this will be identified within the project brief.

07.029. Electrical designers must make due allowance in their documentation for all the metering requirements on ANU projects. Particular emphasis shall be made for correct current transformer (CT) provisions, potential fuses, shorting out test blocks, safe access spatial allocation for the required metering equipment and meters, connection of the meters to the Energy Management Systems (EMS). The final metering commissioning and EMS integration will be performed by contractors that are directly engaged by the ANU.

07.030. Data points should be provided adjacent each main switch board, mechanical services switchboard or distribution board that have meters installed to allow for connection to the EMS. Allow for 1 data point per meter and a minimum of a double data outlet per board. Consult with F&S if consolidation is preferred for boards with several meters.

07.031. Water meters should be connected to the BMS. Provide a double data point adjacent to the water meter location. Water meters that are used for control functions relating to mechanical services (such as leak detection) may connected directly to the BMS.

Lighting

General

07.032. In general all luminaires shall be sourced from a reputable and preferably from an Australian manufacturer.

07.033. All luminaires shall be provided with a 7- 10 years full replacement warranty period.

07.034. The luminaires supplied must be locally supported with respect to spare parts availability and providing services.

07.035. All shop drawings and specifications of all equipment and systems must be provided to ANU and the ANU representative for review and approval before any equipment ordering and commencement of works.

07.036. Under a D&C project, the contractor shall be fully responsible for the complete design of the lighting services installation including providing of all calculations and drawings and other technical information and specifications in order to demonstrate compliance with all codes, standards, university requirements and design parameters.

07.037. Lighting calculations shall be done in either Dialux or AGI software, for all areas in which proposed luminaires will be utilised and these calculation files with a PDF copy of illuminance grids must be submitted to ANU and ANU's representative for review.

07.037. Electrical contractor and/or the Electrical Consultant must conduct a detailed design including lux levels, glare, light colour temperature, mounting/installation type, etc and provide recommendations on light fittings selection suitable for installation location and as per recommendations of AS/NZS 1680 series of Standards. Only reputed light fittings (e.g., Bega (Light Culture), Thorn (Zumtobel), Philips, Thorlux Lighting will be considered. Specify supply lead times for each of the fittings in the tender submission.

Indoor Lighting

07.038. Indoor lighting shall be designed in accordance with the relevant sections of the latest version of the *AS 1680 Interior and workplace lighting (Lighting Code)*. Energy efficiency measures shall be in accordance with the NCC Section J.

07.039. Luminaires shall comply with the requirements of *AS/NZS 60598.1 Luminaires - General requirements and tests*.

07.040. Emergency evacuation lighting shall be provided in accordance with the requirements of the latest version of the *AS 2293 Emergency evacuation lighting for buildings*. Fixtures shall be the LED single point type. Refer to ANU General Electrical Specification for further details.

07.041. Luminaires considered in the design shall be energy efficient, robust in construction and be installed in locations that are easy to maintain without the need for sophisticated access equipment. All luminaires and internal components shall have approval for use in Australia. Where diffusers are used they shall be tight fitting and be appropriately IP rated to prevent the ingress of dust and insects.

07.042. All luminaries must have resistance to dirt built up and must have robust and easy-to-use luminaire fixings to the mounting surfaces. Fixings must facilitate the removal of the luminaire without causing any damage to any part or the underlying mounting surface.

07.043. The illumination levels as recommended in the latest version of AS 1680 for various applications such as offices, educational, workshops and laboratories shall be adopted. Glare and veiling reflections where considered a problem shall be accommodated in the design.

07.044. Average maintained illuminance levels for internal spaces will comply with lux levels as stated within the relevant parts of the latest version of AS1680.

07.045. All lighting system products and luminaries proposed must demonstrate proven track record of performance and longevity in similar comparable applications and spaces. Only reputed light fittings (e.g., Bega (Light Culture), Thorn (Zumtobel), Philips, Thorlux Lighting will be considered. Specify supply lead times for each of the fittings in the tender submission.

07.046. Lighting designers must use LED type lighting in lieu of traditional forms of lamp technology.

07.047. The contractor must submit the following technical details and specifications for all luminaries that are proposed by the contractor. This includes but not limited to :

- a. Manufacturer's data sheet (make / model)/technical Specifications.
- b. Luminaire compliance certificates.
- c. LED Test reports.
- d. Luminaire photometric details/diagrams.
- e. Luminaire Lumens
- f. Type of Reflector
- g. Type of Diffuser
- h. Light Output Ratio
- i. Control Gear (make/manufacturer/model)
- j. Ingress Protection (IP) Rating

- k. Warranty.
- l. Luminaire construction.
- m. Physical dimensions.
- n. Mounting details.
- o. Control gear.
- p. DALI control capability.
- q. Type of lamp (make /manufacturer) and wattage.
- r. Correlated colour temperature and tolerance.
- s. Colour rendering index and tolerance.
- t. Efficacy.
- u. LED lamp future replacement arrangement.
- v. EMC compliance.
- w. Unit price.
- x. Country of origin/manufacture.

07.048. Delivery lead time and images of the luminaire. The ANU has standardised on lamp colour temperature and unless otherwise indicated this shall be 4000 K with a colour rendering index (CRI) between 80-90.

07.049. Energy management lighting control systems as applicable under NCC Section J, shall be considered for all major and minor lighting installations such as:

- proximity/motion detectors in offices teamed with local switches;
- proximity/time controls for corridor, egress and entry paths;
- after hours controls;
- daylight harvesting;
- automatic dimming systems;
- individual control of lighting near perimeter windows;
- time switches; and
- Proprietary lighting BMS.

07.050. Lighting controls shall be determined on a project-by-project basis after discussion with the Principal's Representative. All office lighting projects greater than 100m² shall be provided with motion sensor and timeclock control.

07.051. Lighting designs for lecture theatres, large conference rooms may require integration with audio visual systems. Refer to the Principal's Representative for details. The lighting control and the audio/visual systems shall be designed and installed to be a

complete system by each trade such that each trade can complete their scope of works independently of the other.

07.052. Lighting designers shall submit brochures of all proposed luminaires and lighting controls at the PSP or the Final Sketch Plan (FSP) stage.

Outdoor Lighting

07.053. Outdoor lighting is segregated into the following categories:

- footpath, cycleway lighting;
- road lighting;
- pedestrian crossings;
- car park lighting including disabled access;
- fixed lighting to buildings and external lighting;
- architectural, feature, sports, signage, CCTV and landscape lighting;
- special application lighting for sensitive areas such as Observatories etc.; and
- public activity areas.

07.054. As the ANU has diverse applications for exterior lighting, early discussion with the Principal's Representative will provide further guidance to the designer on the best approach for a particular application.

07.055. Outdoor lighting where applicable shall comply with the various sections of the latest version of the *AS 1158 Lighting for roads and public spaces*. In addition the design guide principles as identified in the latest version of *AS 4282 Control of the obtrusive effects of outdoor lighting* shall also be followed.

07.056. For sports lighting, the relevant sections of the latest version of the *AS 2560 Sports Lighting* are applicable.

07.057. Lighting designers should also be aware of the [National Capital Authority Outdoor Lighting Policy](#) where large areas of the ACT are now located in a designated area requiring the application of specific lighting design principles

07.058. Luminaires installed in external environments shall be sealed to prevent the entry of water, dust and insects and shall be rated at IP66.

07.059. Lamps shall have a colour temperature of 4000 K.

07.060. Colour rendering Index values shall be between 80-90.

07.061. Luminaires shall be selected to minimise light pollution above the horizontal plane. Outdoor lighting shall be of the LED type.

07.062. External lighting shall in general be automatic in operation and be controlled by either a central photo-electrical cell or a Building Management System (BMS) if one is available. For most operations at the Acton campus, exterior lighting is controlled by a

signal from the BMS. Switchboards shall incorporate override switches so that external lighting can be tested during business hours.

07.063. Lighting columns where used shall be tapered steel with a hand hole at the base. There may be a requirement for columns and associated luminaires to be painted a specific colour to be discussed with the Principal's Representative. Columns shall be flange mounted with rag bolt footing assembly. Columns shall be engineer-designed for the particular soil, terrain and wind conditions. A Residual Current Device (RCD) breaker shall be installed in the hand hole at every column. Water ingress protection to this hand hole should be ensured. Column heights and the general configuration of the column (i.e. outreach arms) shall be discussed with the Principal's Representative. All columns shall be fitted with a column number label obtained from the Principal's Representative. Some lighting columns may require to be multifunctional to accommodate other services such as WiFi and CCTV. Refer to the Principal's Representative for direction.

07.064. In some circumstances it may be appropriate to consider stand-alone solar powered lighting with back up batteries; however, any proposals like this shall be discussed with the Principal's Representative i.e ANU Engineering team.

Footpath and Cycleway Lighting

07.065. Footpath and cycleway lighting shall be designed to meet the P2 performance category as described in the latest version of the AS 1158.

07.066. Where footpath and cycleway lighting is required to be mounted on columns, column height shall generally be 5.0 m above ground.

Road Lighting

07.067. The ANU has numerous campuses and facilities with significant variations in road configuration and traffic density. Prior to commencing any design work, lighting designers shall contact the Principal's Representative to establish the design parameters for the particular road.

Pedestrian Crossings

07.068. Lighting for pedestrian crossing shall be designed to meet the requirement of the latest version of AS 1158.

07.069. The lighting designer shall make a recommendation for the lighting category based on the operational specifics for the road.

Outdoor Car Park Lighting

07.070. Outdoor car park lighting shall be designed to meet the P11c performance category as described in the latest version of AS 1158.

07.071. Parking spaces intended to be used by people with disabilities shall comply with P12.

07.072. Where car park lighting is required to be mounted on columns, column height and column configuration shall be discussed with the Principal's Representative. Generally luminaire heights for car park lighting should be in the order of 6.5 m

Fixed Outdoor Lighting to Buildings and external lighting:

07.073. Where consultant is engaged, the consultant shall provide options to ANU on the selection of the luminaires to be located on building facades. The Consultant shall then seek approval from the Principal's Representative and submit luminaire brochures for approval at an appropriate point such as the PSP or FSP stage.

07.074. Luminaires shall be low maintenance, of robust construction, have IP ratings as previously identified and be installed in readily serviceable locations.

07.075. Wall mounted luminaries with a downward direction to enable light spread across the horizontal plane are to be used so as to minimise upward light spill and light pollution.

07.076. Exterior lighting shall comply with the requirements of the latest version of AS 4282 – Control of the obtrusive effects of exterior lighting.

07.077. Pole mounted lights shall have provision for separate power and data services within the pole, as per AS 3000. The poles shall have ability to install and hold Wi-Fi or security cameras.

07.078. Bollard luminaries are not acceptable considering vandalism events and accidental damages by vehicles.

07.079. External lighting shall have corrosion protection, minimum IP66 ingress protection, IK07 impact protection and be of marine grade, die cast aluminium body.

Architectural, Feature, Sports, Signage, CCTV, Public Space Lighting

07.080. These are all specialised areas and where required, further advice should be sought from the Principal's Representative prior to commencement of work.

07.081. The use of low-height bollard luminaires and step lights is not supported due to maintenance issues. Similarly uplighters are not recommended as they may not conform

with dark sky lighting principles. Refer to the Principal's Representative for further advice.

Special Applications - Observatories

07.082. The ANU maintains deep space observation facilities at Mt Stromlo, ACT and Coonabarabran, NSW. Outdoor lighting to these facilities will need special consideration. Lighting designers shall make reference to the latest version of AS 4282.

Telephone and Data Communication Cabling

07.083. The ANU Information Technology Services (ITS) is responsible for all matters pertaining to telephone and data services at the ANU. The Principal's Representative is responsible for ANU ITS input for the Project.

07.084. Because of the commonality with electrical and datacom services, designers are required to liaise with the Principal's Representative in the planning and design of these services.

07.085. The ANU ITS [Cabling Specifications](#) should be access in all cases for guidance on the specification and installation requirements for data cabling.

Power Factor Correction

07.086. Where a new construction project is planned, Consultants will be required to include for adequate power factor equipment to ensure that the installation will operate at a lagging power factor not below 0.98.

07.087. PFC equipment shall have high level communication capability to provide status output to the ANU BMS.

07.088. Proposed power factor equipment shall be discussed with the Principal's Representative during the early design stage. Power factor associated with mechanical plant shall also be addressed.

07.089. All PFC units shall be provided with de-tuning reactors to avoid damage caused by harmonics.

Surge Protection

07.090. All new main switchboards or existing main switchboards subject to major changes shall be fitted with surge protection devices. Refer to ANU General Electrical Specification for further details.

07.091. Surge protection shall be provided at the main switchboard/MSSB and at all distribution boards.

07.092. All Surge protection devices shall be warranted for a minimum of 5 years.

07.093. Main switchboards shall be fitted with TERCEL Isosurge or ANU approved equal surge diverting devices. The diverters shall comply with *AS 60099 : Surge arresters - Metal-oxide surge arresters without gaps for A.C. systems*. The surge arresters shall be connected to the load side of the main switch if applicable, be protected from fault currents, have an isolation facility from the active conductors and a means of failure indication visible without the need for tool access. Surge devices shall have an output capability for connection to the ANU Building Management System.

Lightning Protection

07.094. Consultants shall seek confirmation from the Principal's Representative if their commission extends to providing lightning protection risk assessment advice and subsequent lightning protection design.

07.095. If it is deemed that lightning protection is required for the project, it shall be designed and installed in accordance with the requirements of the latest version of AS 1768 Lightning protection.

07.096. All pipe risers, down pipes and metal masses and incoming metal pipes shall be bonded in accordance with the requirement so AS/NZS 1768 Lightning protection.

Photovoltaic Arrays

07.097. Consultants involved in the design and specification of solar photovoltaic arrays shall discuss proposals with the Principal's Representative at the early planning stage before proceeding with the design.

07.098. All interfacing and connection of the PV system with the Building Electrical infrastructure should be discussed and approved by the Principal's Representative at the early planning stage before proceeding with the design.

07.099. Refer to Section13 for PV System.

Switchboards

General

07.0100. This standard covers all switchboards that form part of an electrical installation, including the Main switchboards (MSB), distribution boards (DB), Mechanical Services Switchboards (MSSB) and motor control centres (MCC). All Switchboard and their locations shall be approved by the Principal's Representative

07.0101. Switchboard design shall adequately address the intended function, switchboard location, load rating and prospective fault levels, harmonics voltage fluctuations and in-situ environmental issues (ambient temperature, humidity, and pollution such as brake dust, ventilation, ingress protection (IP) rating, vermin-proofing and so forth). All major

components shall be arranged such that they are readily accessible for maintenance or replacement.

07.0102. All new switchboard shall be scanned with a thermographic camera immediately when the switchboard is energised and is at full load. Further scans are required six (6) months into the Defects and Liability Period (DLP) and four (4) weeks prior to the end of the DLP. These reports and photos, along with observations shall be submitted to the Principal's Representative for review and acceptance.

07.0103. The thermographic scans shall be undertaken on the following parts of the Switchboard;

- Exterior of switchboard
- Cable terminations
- Busbar links
- Switches
- Isolating links
- Circuit breakers

07.0104. All new switchboards shall have at least 30% spare capacity both in the number of physical spaces and current carrying capacity.

07.0105. Switchboards shall be configured to facilitate switching in accordance to AS/NZS 3000:2018.

07.0106. All circuits shall be verified.

07.0107. Main Switchboards and Distribution Boards must be completely custom-built, made by an established manufacturer and be of the totally enclosed type. Refer to the Main Switchboard and Distribution Board sections below for approved manufacturers.

07.0108. Consult with Facilities and Services to determine the build requirements for Mechanical Services Switchboards for complex, critical or larger installations.

07.0109. Switchboards shall contain a busbar assembly, separate neutral and earth bars.

07.0110. Drawings of all switchboards shall be provided for approval before manufacture and type test certificates shall be provided upon request.

07.0111. Preferred colour for all electrical Switchboard including MSB and DB must be Antique Dark Silver (2nd preference Black Hammer-stone) externally with Gloss White internally while for all Mechanical Services Switchboards board MSSB preferred colour must be Orange Ripple X15 externally with Gloss White internally.

07.0112. An existing switchboard shall be replaced with a new switchboard if it does not have enough capacity to accommodate the required loads, either in current carrying capability or physical space. If appropriate, a new chassis could be installed if there is sufficient room within the switchboard enclosure and the enclosure is in good condition.

07.0113. Modular constructed and Off-the-shelf fabricated Switchboards are not permitted for Main Switchboards and Distribution Boards and as such would be rejected.

07.0114. All switchboard(s) components shall be of a similar type, manufactured by the same manufacturer and mounted so that they operate in a common direction. All switchgear components manufacturers shall be approved by the ANU Engineering team at the tender stage.

07.0115. When an existing switchboard is identified as requiring replacement with a new switchboard, relevant calculations shall be carried out as part of the design. All existing circuits shall be identified and tested prior to reconnection.

07.0116. When replacing a switchboard, individual connectors are not to be used to extend sub-circuit cables when the cables are too short. All cables shall be joined as a group using appropriately sized distribution terminals mounted and labelled appropriately. Examples would be to mount a terminal strip within the switchboard or use a terminal block mounted in a separate cubicle or a junction box.

07.0117. It shall be possible to commence extension of the switchboard(s) in the future, by bolting on additional sections without a shut down. Connections to energized busbars and other live connections will only be carried out during a complete shutdown.

07.0118. All switchboard metal work shall be individually bonded to earth, including star washers under nuts or screws, a bad connection shall not affect the earthing of other adjacent metalwork panels.

07.0119. All switchboards where required to have lockable doors shall be fitted with an ANU Facilities and Services Division standard access lock Lowe and Fletcher 92268.

07.0120. All switchboards in fire egress routes shall comply with the requirements of the Building Code of Australia and be fitted with smoke seal door gaskets.

07.0121. Drawings & manufacturers of all switchboards shall be provided for approval before manufacture and type test certificates shall be provided upon request.

07.0122. Power-CAD models indicating all technical details must be prepared and submitted (including the model file) to the ANU for review and approval as a part of all Switchboard replacement Projects.

07.0123. Refer to Section 7.1 for requirements on sub-main cabling.

Main Switchboards (MSB):

07.0124. All switchboards shall comply with the latest versions of AS3000, AS61439 and latest amendments.

07.0125. Form of segregation for main switchboards rated over 800A must have Form 4B while those rated up-to 800A must be Form 3B.

07.0126. The MSB switchboard(s) shall have a fault rating not less than 50KA for 1 Sec or as per calculations. These calculations shall be submitted to ANU for review/approval.

07.0127. All switchboards rated 800 A or more shall be constructed to withstand internal arcing faults and stresses caused there- by and be designed for arc-containment.

07.0128. Main switchboards must be provided by one of the following approved companies: Canberra Switchboards, K E Brown Electrical Switchboards or R N Baker Switchboards. Brooks Marchant is also an acceptable company for main Switchboards rated up to 630A.

07.0129. The MSB shall be mounted onto a fixed galvanised dipped plinth manufactured from 75mm x 40mm channel iron.

07.0130. Unless otherwise indicated main switchboards if required to power essential equipment and services shall have a facility to connect to mobile emergency power generation equipment.

07.0131. All necessary equipment shall protrude through turned edge escutcheons.

07.0132. Power supplies to safety services and the services listed in Table 5 in Appendix A that are required to operate during fire and other emergencies shall be arranged as described in clause 7.2.3 of AS/NZS 3000:2018.

07.0133.

Distribution Switchboards

07.0134. All Distribution switchboards shall have the following:

- Totally enclosed, continuously welded, metal-clad type fabricated from a minimum of 1.5 mm sheet steel with radiused corners and all visible joints ground smooth
- Lockable (L&F 92268 keyed)
- Hinged escutcheon
- Custom built
- Minimum Form 2A
- Protection rating: IP65 (Outdoor) and minimum IP43 (Indoor)
- 160 Amp minimum main switch size
- Earth and Neutral bars,
- Hinged doors (lift-off panels will not be accepted)
- Circuit identification and schedule cards supplied

- Distribution switchboards shall be configured to provide separate sections for lighting circuits, power circuits and mechanical services circuits (wherever applicable).
- Each switchboard section will include spare pole capacity/space (min 30%) for the future circuits
- Residual current device (RCD) protection

07.0135. Circuit breakers controlling final sub-circuits and protection equipment must be manufactured by Schneider Electric.

07.0136. For loads 10 Amps up to 100 Amps, Miniature Circuit Breakers (MCB) shall be used. DIN mounted MCB's with integral RCD protection within a single pole shall be used

- For loads 100 Amps to 800 Amps, Moulded Case Circuit Breaker (MCCB) shall be used.
- For loads above 800 Amps, withdrawable Air Circuit Breakers (ACB) shall be used.

07.0137. Distribution Boards must be provided by one of the following companies: Brooks Marchant Switchboards, Canberra Switchboards, K E Brown Electrical Switchboards, Lai Switchboards or R N Baker Switchboards.

Switchboard construction

07.0138. Switchboard cabinets shall be of the totally enclosed, continuously welded, metal-clad type fabricated from a minimum of 1.5 mm sheet steel with radiused corners and all visible joints ground smooth.

07.0139. Switchboard Doors must be chromium plated hinges, have double turned edges, be fitted with lockable with L&F 92268 key & latching bars where appropriate and shall swing through an arc of 135 degrees

07.0140. All necessary equipment shall protrude through turned edge escutcheons. Escutcheons plates must be behind the doors and shall be hinged and be secured with captive screws.

07.0141. All external cabinets shall be ventilated with louvered openings with gauze screens across openings.

07.0142. Cabinets shall be designed to minimise hysteresis and eddy current losses.

07.0143. Outdoor switchboards shall be constructed to IP65. Fabrication shall minimise the number of gasketed openings to the outside of the switchboard and shall provide for a sloped roof.

07.0144. Gland plates shall be manufactured from 3mm aluminium, sealed with a gasket and bonded to earth.

07.0145. Before the application of external finishes, thoroughly rub down after fabrication and coat with etching type, rust-inhibiting primer. Finish with at least two (2) coats of an approved enamel or powder coat. All interior surfaces are to be finished with white enamel. Verify external paint colour before application.

07.0146. Provision shall be provided for 30% future expansion of the main busbar system; all junctions associated with the installation of copper busbar shall be established using full lap-joints or compression joints.

07.0147. All 'live' sections of a main switchboard, within cable sections and wiring chambers, etc. shall be fully insulated to prevent contact with live parts.

07.0148. The switchboard manufacturer will perform temperature rise calculations to AS60890. All busbars will be sized & de-rated accordingly to deliver the required ampere rating.

07.0149. All Busbars shall be made from hard drawn, high conductivity copper with rolled edges. The minimum busbar rating (continuous) is 160 A.

07.0150. All busbars shall be of high conductivity copper with full size neutral identified with phase colours and so arranged as to facilitate future extensions. Busbars shall be insulated.

07.0151. Cabinets for outside installation shall be mounted on galvanised metal supports bolted to a concrete plinth. External cabinets shall be fitted with anti-condensation heaters rated at 100 watts per cubic meter of cabinet volume. An accessible thermostat shall be provided. Indoor cabinets shall have a minimum degree of protection of IP42 unless otherwise specified.

07.0152. All miniature circuit breakers on a switchboard shall be of the same manufacture and must be either SCHNEIDER or TERASAKI.

07.0153. Mechanical Services Switchboards shall be complete with a double GPO, fire trip lamp and lamp test button as a minimum.

Switchboard Labelling:

07.0154. Circuit reference labels of Traffolyte™ style with black letters/white background or other ANU approved non-deteriorating material, fixed by means of screws, rivets or glue shall identify every relay, push button, fuse, circuit breaker, switch, meter, indicator light, terminal block, motor and other apparatus including all power sockets and light switches.

07.0155. Labels for power sockets and light switches shall be located adjacent to the accessory and shall refer to the switchboard origin and circuit breaker number e.g. DB-1 CB32. An approved alternative accessory labelling system is the Clipsal Pro Series.

07.0156. All control circuit wiring shall be labelled at each end and in junction boxes by an approved non-deteriorating means with circuit reference numbers. All wiring shall be colour coded to maintain phase sequence identification.

07.0157. A4 size typed circuit schedules as per standard ANU format shall be fitted inside the doors of all switchboards behind clear rigid plastic panels, and shall comprise the following:

- Circuit reference number
- Size, Length, No. of cores and type of cable and Submains
- Description of circuit
- Name of switchboard
- Name of switchboard feeding the board
- Switchboard Reference Number

07.0158. The switchboard name plates must provide with the below typically information:

- Manufacturer's name or trade mark (mandatory)
- Serial number/drawing number (mandatory)

- Date of manufacture (mandatory)
- Relevant standard (eg. AS/NZS)
- Type of current (and frequency, in the case of a.c.)
- Rated operational voltages
- Rated insulation voltages
- Short-circuit withstand strength
- Degree of protection
- Type of earthing system
- Weight
- Form of internal separation

07.0159. A template for the ANU standard circuit schedule will be provided with the contract documents. Modify the template as necessary to record the circuit details for each switchboard and in addition to the printed copy in the switchboard, provide an electronic copy with works-as-executed documentation.

07.0160. All main switchboards shall have located in near proximity an A1 sized copy of an up-to-date version of the electrical single line diagram mounted behind a rigid clear panel.

Protection:

07.0161. Conduct a fully discriminating/cascading protection system applicable to all supplies including, but not limited to mains, generator, PV and other renewable energy sources and submit to ANU for review.

07.0162. Discrimination shall occur for all fault conditions up to and including the maximum prospective 3 phase fault current conditions.

07.0163. The electrical contractor/consultant shall submit the type, rating and trip unit setting of all circuit protective devices along with the switchgear manufacturer to the ANU for review. All short-circuit calculation and overcurrent calculation studies conducted using various electrical design software's e.g., ETAP etc. along with the selection of the cables and circuit breakers must be provided to the ANU for review and acceptance. The results and documents should also provide the following information/calculations:

- Voltage drop values
- Fault level calculations for each level
- Time/current coordination curves for the various breakers.

- Cable and CB sizing
- Schedule of all equipment, associated characteristics and settings.
- Earth fault loop impedance values.
- MSB, MSSB, DB system grading along with fault level calculations.

07.0164. Provide isolators, contactors and switches with upstream protection to prevent damage from downstream fault currents up to the maximum three phase bolted fault current at the load side of the device.

07.0165. For new Buildings, model the whole electrical infrastructure of the building right from the concerned Evo energy sub-station in ETAP and submit the complete model for review comments and approval by the ANU Engineering team. The model should be completely detailed from the substation secondary down till the end user's outlets.

Sub-mains Cabling

07.100: Cables within switchboards shall be neatly run minimising excessive length, be firmly supported to ensure minimum stress on terminations, for example, circuit breaker terminals, and shall not impede access to the neutral and earth bars.
07.101: All other cables shall be colour coded in accordance with table 3.4 of AS/NZS 3000:2018.

07.102: Cable selection shall be designed taking into consideration; current carrying capacity requirements, voltage drop and short circuit temperature rise.

07.103: New cabling shall be copper as standard. Approval shall be sought for use of aluminium cabling.

07.104: Any redundant cabling shall be must be removed from site.

07.105: New cable trays and ladders shall be provided with 50% spare capacity.

07.106: All consumer mains and sub-mains shall be installed on cable trays. Main runs of final sub-circuits are to be installed on cable trays.

07.107: Earth all cable trays, ladder trays in accordance with the requirements of AS3000.

07.108: Position cable tray supports to give adequate access for inspecting, replacing, or adding cable.

07.109: The cable tray shall be galvanised steel with 20mm (minimum) high folder edges.