THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA

The University of Newcastle

Infrastructure and Facilities Services

Electrical Specification

General Electrical Specification

19st January 2021

Version 1.4

UON-ESS-101

THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA

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Contents

1. General

1.1. Purpose

The purpose of this document is to convey the extent of investigation and consideration relating to Electrical Engineering Services associated with new construction, major and minor alterations to buildings and utilities which are owned by or proposed to be sited on the campuses and satellite facilities of the University of Newcastle, NSW Australia.

The intent is to ensure consistency of services engineering provided and including the early review and incorporation of all building services with a view to ensuring proposed works can be supported by the site infrastructure. This review will identify areas which will require attention, modification, Rectification and installation which may be necessary to ensure the proposed works can function and Operate in the most efficient and effective manner.

This document shall be used in conjunction with relevant technical specifications and standards as listed in Appendix A. The Designer shall ensure the latest documents have been received and are being applied in the design.

1.2. Application (Uniform to Project)

This Specification and associated documentation are to be used and referred in the early stages of project conceptual design with continued reference throughout design and development, to ensure all possible electrical services issues and constraints are considered and subsequently accommodated. Specifically this Specification shall be issued with, and read in conjunction with 'Request for Tender' (RFT) and/or 'Expression of Interest' (EOI) documentation issued by the University or contractor acting on their behalf. The design produced using these Specifications and associated documents shall be submitted to the UON for approval prior to commitment of funds or resources by the contractor.

1.3. Standardisation, Supportability and Maintainability of Equipment

All specified services and equipment shall, as far as practicable, be standardised on a site basis and be provided in compliance with the UON-ESS-105 Preferred Equipment List. Designers shall ensure that any existing standards are maintained as a minimum or exceeded wherever appropriate. The designer shall ensure they are provided with the latest versions of available University specifications and requirements.

The designer shall assess the need for key or essential spares to meet the required availability and shall also include the requirement for the supplier to nominate essential recommended spares. Building services installations and plant room layouts shall allow for appropriate and easy access for the purpose of operations, maintenance, repair, and replacement of major components. Where equipment and services are installed exterior to the building, provide a screened and secure enclosure.

Designers shall select, after comparing all design options available, the most long-term cost effective design solution that will meet the requirements of this brief and those specific to the establishment or facility. Designs shall be engineered to include equipment and materials complying with the appropriate

standards. Generally, equipment and materials not on the UON-ESS-105 Preferred Equipment list shall not be specified by make and model number but shall be selected on the basis of their performance, suitability, maintainability and cost effectiveness.

Any proposal to specify equipment not on the UON-ESS-105 Preferred Equipment List, by make and model shall be formally documented for approval by the UON and shall include ESD principals and shall incorporate energy efficient design.

The designer is responsible for flagging any requirements to notify any relevant statutory body of changes or additions to the UON electrical system.

1.4. Existing Electrical Installations

All electrical changes or additions shall be designed to integrate with the existing electrical services. The designer shall investigate the system Capacity, Protection Settings, layout, physical constraints and any other variables that may affect the operation of the new installation of the existing electrical infrastructure.

All individual projects shall be considered in context of the impact and implications on existing campus services and identify solutions that may be beneficial to other buildings and services not immediately within the scope of the respective project.

1.5. Energy Efficiency

All electrical design shall incorporate energy efficient sustainable design practices in accordance with University policy and standards. Electrical design shall also take into consideration any recommendations made by the UON ESD (Environmentally Sustainable Design) Tool. Applicable energy rating schemes (over and above BCA requirements) will be considered on a project by project basis and will be incorporated in the briefing documents.

1.6. Site Safety and Work Permits

All works including site inspections shall be undertaken in strict conformance with the Universities Health, Safety and Environment requirements, including policies and procedures. The designer shall request the policies for implementation during the design and incorporation within design documentation.

1.7. Safety in Design

Designers of Plant and Structures must comply with the requirements of the NSW WHS Act and WHS Regulation 2011. A safety in design risk assessment will be developed for the Project and proposed safety controls will be reviewed with the client at critical stages in the process.

In undertaking the Safety in Design process:

- Establish the context for the design.
- Identify the foreseeable uses of the design.
- Identify the hazards relevant to the Project as a whole and each phase of the Project.
- Undertake an assessment of risk based on the ALARP (As Low as Reasonably Practicable) model.
- Develop the Safety in Design Risk Assessment.
- Identify potential control measures and determine residual risk.
- Monitor and review the design process at critical stages.

- Communicate and consult with the Client regarding Safety in Design.

1.8. Design Life

A whole of life study, which would include life cycle costings for all building components, is required for UON projects. The design life selections for building components and systems located within a University structure will be expected to exceed standard industry practice for a typical commercial building.

1.9. Distribution System Terminology

For the purposes of this document and when dealing with the UoN the following distribution terminology applies.

High Voltage Substation
This is the building, high voltage transformer and switching equipment that provide power to the Low Voltage Substation.

Low Voltage Substation
This is the building and equipment that receives power from the High Voltage Substation and distributes it the Main Switchboard housed in each building.

Main Switchboard or MSB – This is the initial electrical board in a building that provides power to the distribution boards. This board receives power from the Low Voltage Substation.

Distribution Board or DB – This is the board that supplies power to the final sub circuits. The DB is fed from the Main Switchboard.

2. Electrical Services.

Electrical installations shall comply with all relevant UON and Statutory Standards, Codes, Acts, specification and Specifications. Where Australian Standards are not available, recognised international or overseas national standards shall be used where they are relevant to the type of installation or equipment and to the installation conditions in Australia. The designer shall detail in the design report all standards and legislation adopted together with a clear indication of the extent and field of application.

2.1. Electrical Network

Any design for the site electrical network is to be designed to minimise outages that would result from maintenance activities or in the event of a fault; by use of rings and redundancy. Power factor correction shall be undertaken at the point of connection to achieve a power factor of at least 0.96.

All new designs shall consider how any new infrastructure fits into the overall campus electrical infrastructure including existing ring systems. The new design shall take into account the impact of the new project on the existing electrical infrastructure. When considering any reconfiguration of the system, the benefit to not only the new project but also other existing campus facilities should be considered.

3. Specifications, Regulations, Standards and Codes

As a minimum, the following Specifications, Regulations, Standards and Codes define the design and installation requirements that are applicable:

3.1. University Electrical Specifications.

Below is a list of UON Electrical standards that may be relevant to any electrical installation. Electrical issues that are cover in the General Electrical Guideline with be covered in greater depth in the specifications below.

- UON-ESS-101 General Electrical Specification
- UON-ESS-102 Distribution Board Specification
- UON-ESS-103 External Lighting Spec
- UON-ESS-104 Emergency Escape Lighting and Illuminated Exit Signage
- UON-ESS-105 Preferred equipment list
- UON-ESS-106 Generators
- UON-ESS-113 High Voltage Substations
- UON-ESS-111 Interior Lighting and Control
- UON-ESS-112 Main Switchboard Specification.
- UON-ESS-109 Supply and Installation of Photo Voltaic array
- UON-DSS-001 CAD Drafting Standards

3.2. Other University Specifications.

Below is a list of other UON technical specifications that may pertain to project works.

- CCTV Spec
- Security
- IT

3.3. Statutory Standard, Codes, specifications and Guidelines.

- The current version of the Building Code of Australia (NCC) – National Construction Code.
- All local Supply Authority requirements.
- WHS Act 2011.
- NSW Services and Installation Rules.
- Australian Standards
- University High Voltage Networking Strategy.
- UON High Voltage Master Plan
- UON ISMP

4. Outline of Works

The scope of services to be designed to requirements include but may not be limited to the following:

- Power supply from University HV network.
- Any required Substations (Review existing power supply, provide site demand assessment and document any required supply augmentation upgrades plus any additional works).
- Main switchboard's (MSB) and metering.
- Internal and external lighting and emergency lighting systems (incorporated into the Campus wide emergency lighting strategy).
- Interior and exterior power reticulation, MSB, DB's and cabling etc.

- Data and communications cabling and equipment.
- Security and Access control systems.
- Electronic fire detection systems.
- Lightning protection systems.
- UPS systems for communication equipment as required.
- Back-up emergency generator (subject to project specific requirements).

Incorporating all electrical systems and services into the existing University infrastructure as required.

5. External Electrical Services

5.1. Existing 11kV System

The Designer shall confirm the owner of the site electrical supply assets. These may include both Supply Authority and University owned assets (note that the 11kV reticulation system on the Callahan Campus is owned by the University).

The capacity of the existing Ausgrid 11kV feeders and existing loads are unknown. The designer is to review site requirements and consult with the supply authority to determine any required upgrade of these services.

5.2. Service Corridors and Easements

The designer shall ensure that the engineering services are developed in a manner that do not cross roads, pathways, car-parks, and other paved surfaces if possible. If this cannot be achieved, clearance is to be given by the UON prior to proceeding with the works.

Wherever possible, electrical services shall be located in the designated service corridors within road reserves as identified. If this cannot be achieved, clearance is to be given by the UON prior to proceeding with the works.

HV Cabling shall be installed in conduit or direct buried with appropriate mechanical protection. HV rings and spurs shall be protected with translay and directional protection relays. All HV cable are to include Surface Cable Markers.

The designer shall ensure that all underground engineering services locations are surveyed by a UON approved locating service and recorded on As-Installed documentation in an accurate manner and provided to the UON. Cables shall be run through cable pits located not more that 100m apart on straight runs and on changes of direction. If required, appropriate cable locating transponders will also be provided between cable pits at a maximum spacing of 20 – 30m.

No high voltage or trunk low voltage services are to remain or be placed underneath buildings or in a position that could conflict with any other proposed building site. Such services, where conflicting with the proposed site shall be relocated clear of the site.

Cable joining for any cable whether above ground or below shall not be used as an alternative to replacing a cable unless prior approval by the UON is given.

5.3. Interface with Existing Services

Where new works are to interface with existing services the designer shall arrange for pre-design surveys of the existing services, where necessary, to ensure the accuracy of existing documentation and the coordination of design. The capacity of the existing services will also need to be determined by the designer.

Where the capacity of existing services is found to be insufficient and the increase in capacity is large enough, the Designer will need to consider alterations to the site High Voltage Networking Strategy.

6. Power Supply

The designer shall ensure that each new, refurbished or leased facility is provided with a suitable power supply in accordance with the requirements of Ausgrid, NSW Service and Installation Rules and AS/NZS 3000:2007. In determining the requirement to achieve this, the designer shall review the existing reticulation system and the feeders to provide an adequate capacity and also the impact to the current energy and network agreements. The designer, when determining if augmentation works are required to the reticulation system, needs to consider the owner of the reticulation and negotiate accordingly.

The designer will ensure that the new or additional load does not adversely impact on current or proposed electricity retail and network connection agreements/contracts.

Where part of the reticulation is owned by a third party, the designer shall liaise with the third party and incorporate any additional requirements. All such requirements shall be agreed to by the University prior to any formal agreement or undertaking being made with any third party.

Where University owned reticulation needs to be modified or augmented to cater for the new or additional load, the designer in consultation with the Project Officer needs to consider the paragraphs below to determine if a Project Electrical Development plan is required. This is to ensure the orderly development of the reticulation system minimising abortive work whilst catering for the future planned requirements of the establishment. They are normally to be undertaken as a preliminary study but are required where the proposed modifications are not simple and where there is insufficient guidance provided by other studies or existing documentation.

6.1. Network Service Provider Augmentations

Where the feeders to the University or establishment are or will be overloaded or where new feeders are required, the designer is to investigate and liaise with the Authority on the options and costs to provide the appropriate power supply. No undertaking should be given without prior formal agreement with the University.
Where it is necessary for Ausgrid to augment their reticulation system, the designer shall submit a report to the Project Officer detailing the negotiations with Ausgrid for consideration and agreement addressing the following:

- Deficiencies in the existing arrangement.
- Proposed power supply arrangement to cater for the establishment, addressing the master plan requirements, and for a suitable period of load growth (normally 15 years where possible).
- The Designer needs to detail the options considered, and how the recommended option was chosen and how this option represents the best option available.
- Ausgrid reticulation arrangement particularly identifying key redundancies or possible failure points in the reticulation system.
- Alternate feeder requirements, if applicable.
- Impact to existing electricity retail agreements/contracts and also network connection agreements or similar.
- Network charges for each option. Consideration should be given to the most suitable supply option on a through life basis (i.e. capital works costs and ongoing network charges). The most cost effective option based on a minimum five (to ten) year payback should be considered, even where this requires connection at a higher voltage or has higher capital works contribution.

- Augmentation costs identifying the contribution to Ausgrid and the basis of these costs. The designer should also identify if the works are contestable and whether it should go to the market to achieve value for money.
- Address any configuration changes required on the University reticulation system and the costs to implement these.
- NPV calculation and through life assessment of the respective costs of each option to assist consideration.

6.2. Reticulation Augmentations

When determining the requirements to provide a power supply for the facility, the designer is to review the existing reticulation including the high voltage system and nearest substations, for adequate capacity; and the High Voltage Networking Strategy.

Where it is found necessary to augment the distribution system the designer shall design the augmentation works in accordance with the Project Electrical Development Plan where available. Where the required augmentation is only relatively simple in nature such as the addition of a single substation and the existing reticulation system has adequate capacity to cater for the new facility or load, the design report is to reflect the outcome of these investigations and detail the proposed works for approval by the University. The design report is to detail as a minimum, the facility assessed maximum demand, existing reticulation loads and capacities, suitability for load growth and the proposed augmentation works.

Alternatively where considerable high voltage system augmentations are required reasonable work to the reticulation system such as a number of substations, more than one hundred metres of high voltage cable or the ring does not have capacity, a project Electrical Development Plan shall be developed by the designer to confirm suitability of the proposed augmentation Development plan requirements are provided below.

6.3. Planning Considerations

Whenever a new substation is augmented or added to a reticulation system an assessment is required on the high voltage system to confirm adequate capacity exists on the feeders to the University and the high voltage rings on the University. If insufficient capacity exists in either, or the extent of work is considerable, a high voltage Project Electrical Development Plan is required to be prepared in accordance with the University High Voltage Networking Strategy. All augmentations and Electrical Development Plans shall be in accordance with this strategy. In determining the required augmentation and the outcomes of the development plan, the designer shall assess the existing loads and capacities, estimate the load of the new facilities and master planned facilities and include sufficient capacity for natural load growth of three percent per annum. Where a current electrical master plan does not exist for the establishment, the development plan must fulfil the basic electrical master planning requirements to ensure that the development plan represents the progressive development of the reticulation to meet the master planned site requirements minimising abortive work in the future growth of the system.

The designer shall also consider all suitable options in determining the recommended system configuration that shall also include the outcomes of any negotiations with Ausgrid. Other aspects the designer must consider include replacing switchgear that is unsupportable, beyond its economic life, or where the switchgear or equipment does not meet the required system performance or fault level.

All substations and equipment affected by the required works shall be replaced or upgraded, however, substations and equipment not directly affected need to be assessed on a case-by-case basis against the available funding for the project (e.g. possible requirement to upgrade upstream 11kV switchboards etc.).

6.4. Investigation of Existing Infrastructure

The designer shall allow to review all relevant plans and reports concerning the university electrical reticulation system and report on the shortfall in information.
Where the electrical reticulation system is to be investigated, the designer shall consider the following and detail the outcome of his investigations in the design report or possibly as a separate report as part of the development plan:

- Additional load contribution from each facility.
- Capacity of each HV ring and feeder.
- Existing load on each HV ring and feeder.
- Any particular operating requirements or constraints (e.g. feeder cannot be operated in parallel continuously, small ring cable sections).
- Planned loads and natural load growth of at least 2% pa.
- Load flow analysis, protection coordination study and insulation coordination study. The load flow analysis shall confirm the voltage regulation of the high voltage system adequately meets the supply characteristics of AS/NZS 3000 for both normal and abnormal load flow conditions.
- Identify under capacity, outdated or unserviceable equipment effected by the works requiring replacement. In investigating this requirement, the designer must consider the high voltage system requirements below. Should any of the HV rings not have sufficient capacity to meet the required loads the designer shall investigate the options to establish sufficient capacity which shall include considering redistributing the load over other existing rings and the establishment of a new HV ring.

6.5. High Voltage System Requirements

In determining the required augmentation work the consultant shall consider the following basic requirements in coordination with the University High Voltage Networking Strategy:

- Each HV feeder is to be able to support the total campus load with the other feeder out of service, unless agreed that the alternate feeder provides only part alternate supply.
- High voltage rings must be able to support the entire ring load in either direction (i.e. open point at either end of the ring.
- Operational facilities and important facilities shall be connected on a ring main system that provides two sources for high voltage supply through switching to the substation supplying the facility.
- Sufficient load growth must be allowed in new high voltage rings. Normally rings should be designed with spare capacity up to around 50% based on master planned loads but no less than 25%.
- High voltage cables shall be separated appropriately to avoid single event failure condition and derating or 5m whichever is the greater. This clearance includes the return leg of any cabling to a substation or switching station.
- All establishments have standardised electrical equipment arrangements that needs to be accommodated and maintained as part of the design.
- Spares and redundancy requirements need to be addressed and catered for as part of the design.

6.6. Substations

New and refurbished substations shall be in accordance with the relevant Australian Standards and University requirements. Where substations are Authority owned, they will be provided in compliance with Authority
Requirements.

6.6.1. Chamber Substations

Generally substations located on the Callaghan Campus shall be Chamber type substations. The substation shall have sufficient capacity to provide redundancy in the event of a fault. The station should be designed with two transformers, sized accordingly to allow its load to be supported by one transformer.

Critical buildings shall be designed with substations with dual supply and bus tie to allow for MSB reconfiguration on-load without the need to disconnect load to reconfigure switching.

Substation LV Distribution Boards shall be supplied to provide substation auxiliary services as well as common outdoor path, car parking and road lighting via PE cell and off/auto/man override switches. Substation LV distribution boards should also be designed to incorporate a manual generator change over switch; and external generator connection point in a location suitable to safely store the temporary generator.

A common substation alarm shall be provided consisting of Circuit Breaker trip alarms, faults, power factor alarms, transformer protection faults etc. The common alarm shall be connected to the University Critical Alarm System (not BMS).

6.6.2. Kiosk Substations

Where a kiosk substation is provided as the only practical option (with approval from IFS), it shall be fed from a HV Switch from the nearest chamber substation as a spur with HV protection at the main switch. The protection for the spur shall be graded and cascaded with upstream protection to prevent tripping of upstream protection should a fault occur on the HV spur.

Kiosk substations shall not be installed as part of a ring or daisy chained as part of the spur line.

6.6.3. Substations General

The substation LV switchboard shall have the capacity to supply the proposed new facility or facilities with spare capacity for future expansion provided for the supply of additional buildings.

Buildings shall be provided with a dedicated Main Switchboard (located as near as possible to the building entry) with a single dedicated supply mains from the substation LV switchboard. The chamber LV switchboard shall not be utilised as a Building MSB. Should expansion of a building require an upgrade of the supply mains cabling, the cabling shall be replaced rather than installing a parallel supply.

All building mains shall be metered within the substation LV switchboard.

6.7. Earthing

Earthing for electrical cabling installations shall in accordance with AS/NZS 3000:2007 and Ausgrid requirements.

Separate earthing systems or earth reference points, where required in buildings, are to be bonded in accordance with AS/NZS 3000, AS/NZS 1020 and AS/NZS 1768. In meeting this requirement the designer is to ensure that the design does not compromise the engineering requirements of the earthing systems and that the potential for earth loops in the facility are eliminated.

When Substation, Switch room, Distribution Board or Main Switchboard upgrade works is being completed, the compliance of the existing earth grid shall be established prior to any submission for the works and the cost of achieving compliance included in any submission.

6.8. Trenches and Cabling

All underground cabling shall be installed in accordance with Supply Authority requirements, NSW Open road requirements and AS/NZS 3000. Site specific requirements shall also be taken into account in the design.

All Mains and Sub Mains cable are to be mechanically protected within 1 meter of the surrounding Floor or ground. Drawings shall be supplied showing the exact location for all in slab electrical wiring or ducting.

High voltage cabling shall be installed in conduit or direct in ground and in a manner that does not attract de-rating, particularly due to grouping. Cable ratings shall be maintained and consideration shall be given to larger cable sizes to avoid significant de-rating due to soil conditions or the requirement to install in pipes in paved areas.

120mm^2 Cu cable is the minimum acceptable high voltage cable size to cater for fault levels unless specifically approved by the UON. The designer shall confirm the required design cable ratings for each ring.

High voltage tee joints or branch joints are not permitted in reticulation systems.

All new high voltage cabling shall be segregated from LV reticulation, communications and control cabling.

All Non-Conductive services whether in conduit, duct or direct buried shall include a tracer wire to enable future service location. Drawings shall be supplied showing the exact location for all underground and “in slab” electrical wiring or ducting. All empty conduits installed in the ground for future use shall include a tracer wire.

6.9. Surge Protection

Parallel surge diverter protection shall be provided for the distribution system and within all MSB’s and Distribution Boards. The surge equipment shall not disconnect the power supplier when operated. Diverters shall be as per the preferred suppliers and equipment list and shall be installed strictly as per the manufacturer’s recommendations. All surge diverters within a building shall be monitored as a common alarm monitored by the Campus Wide BMS systems all overhead and underground junctions shall be suitably surge protected. All surge diverters shall be installed in a way to allow indication flags to be visible without removing any panels or escutcheons. Surge diverters must be labelled accordingly.

7. Uninterruptible Power Supply (UPS)

Uninterruptible Power Supply (UPS) systems (if required) shall meet the UPS equipment specifications and requirements defined on a project by project basis. The designer shall confirm the UPS specification and project requirements with the Project Officer.

Where UPS systems 20kVA or above are required (e.g. data centres), they shall be fitted with internal and external maintenance bypass infrastructure to allow complete removal of a UPS if required while maintaining supply to critical equipment. Additional building services such as ventilation and air conditioning of the UPS rooms shall be considered.

8. Building Electrical Services

8.1. General

All electrical works at UoN is to be completed in a professional tradesman like manner.

If electrical equipment is replaced, changed or moved any surface that was previously obscured by that electrical equipment shall be repaired, painted and finished to match the surrounding surfaces.

All control wiring installed at UoN will include wire numbering at the origin and destination of each wire. A corresponding drawing, to UoN drafting specification UON-DSS-001, shall be supplied with all new control wiring.

When any electrical infrastructure is upgraded or replaced, all redundant electrical equipment, infrastructure and cabling associated with that infrastructure shall be removed. If the cost or complexity of removing this redundant infrastructure is prohibitive, permission should be sort from the UoN to leave the redundant equipment in place.

8.2. Distribution System Terminology

For the purposes of this document and when dealing with the UoN the following distribution terminology applies.

High Voltage Substation
This is the building, high voltage transformer and switching equipment that provide power to the Low Voltage Substation.

Low Voltage Substation
This is the building and equipment that receives power from the High Voltage Substation and distributes it the Main Switchboard housed in each building.

Main Switchboard or MSB – This is the initial electrical board in a building that provides power to the distribution boards. This board receives power from the Low Voltage Substation.

Distribution Board or DB – This is the board that supplies power to the final sub circuits. The DB is fed from the Main Switchboard.

8.3. Lighting Control

Lighting control strategy shall be as per UON-ESS-111 Interior Lighting and Control and UON-ESS-103 External Lighting. This is to include interface with the BMS system.

The minimum standard to be provided is that required by the relevant Australian Standard.

Interior: To AS1680 series.

Exterior: AS1158.3.1 and AS4282.

8.4. Lighting

Interior Lighting

All lighting systems shall comply with the recommendations of relevant Australian standards and the NCC Section J and applicable parts.

All light fittings shall be of high quality, designed for a minimum service life of 20 years and be designed to provide a high level of energy efficiency.

New lighting systems shall be LED type fitting when another lighting technology is not specifically required for it functionality of appearance.

Lighting control systems shall be designed to provide automatic control of lighting. Functions shall include Daylight Dimming, Occupancy Sensing, push button timer, automatic timer and security/Access lighting control as a minimum.

If lighting automation is used in an area the control philosophy shall incorporate functionality that will prevent area users from being left in the dark if no occupancy is detected for extended periods. All automated lighting systems shall include an override switch that allows the lights to be manually switched.

Lighting to toilets, cleaner's rooms, store rooms and the like, must be controlled by Passive Infra-Red motion detectors of a type acceptable to the University. Such detectors shall have adjustable light level sensitivity with reset after an adjustable time period of 10 seconds to 20 minutes.

All Internal Lighting shall comply with UON-ESS-111

8.5. Exterior Lighting

Exterior lighting shall generally have little upward component (“Dark Sky” compliant). New lighting systems shall be LED type fitting when another lighting technology is not specifically required for it functionality of appearance. The designer shall select approved luminaires but shall consider aspects of the luminaire such as bird proofing, water ingress and heat sink configuration and vandal proofing.

All external light poles shall be identified by a unique asset number as approved by IFS. External lighting shall be controlled by timers, photo cells or Passive Infra-Red motion detectors as appropriate.

External lighting mounted on a building or in direct vicinity of a building shall be controlled from within the building. Common exterior lighting such as car park lighting, walk way lighting and road way lighting etc. shall be controlled from a dedicated lighting control panel within the nearest substation. All controlled lighting shall be fitted with Off/Auto/Manual switches and be controlled by PE Cell/Timer or BMS.

All External Lighting shall comply with UON-ESS-103

8.6. Emergency and Escape Lighting

Emergency lighting shall be provided as per the requirements of the BCA. All new emergency lighting installed in new buildings or refurbishment work shall be consistent with the site wide strategy allowing remote management and test facilities and be selected from the preferred suppliers and equipment list. Preference is for low wattage or LED types.

The installed system shall allow ease of addition of fittings, removal and replacement of existing fittings and reconfiguration.

The installing contractor must allow for all installation requirements set out by the manufacturer, and also engage the suitable contractor for commissioning.

All Emergency and Escape Lighting shall comply with UON-ESS-104

8.7. General Small Power

8.7.1. GPO's

GPO's within 200mm of the floor or other working surface, including a desktop, shall be installed in such a manner that any plug is inserted or removed on the horizontal plain.

Wall mounted GPO's shall be mounted at a minimum height of 200mm from the floor to prevent mechanical damage. Any cable supplying a GPO shall drop below the GPO and loop up to terminate into the GPO.

8.7.2. Floor Boxes

Floor Boxes for the distribution of power should only be used with the express permission on the University of Newcastle Asset Engineer Electrical. All floor boxes used on site shall be a soft edge type floor box equivalent to ECD FB4MU. If a floor box is installed to supply power to a table or other equipment that can be moved, the installation shall include a tether between the floor and the underside of the table/equipment, that is shorter than the electrical supply and restrict the movement of the table/equipment. This tether shall prevent the table/equipment being moved in such a way that it would "shock load" or otherwise place stress on the electrical supply cable.

8.8. Emergency Stop Installations

Any emergency stop pushbutton shall include a drawing demonstrating the circuitry under control of that particular Emergency Stop. The Drawing shall be mounted adjacent the Emergency stop to inform building occupants of the coverage provided by that Emergency Stop.

Emergency stop circuits will be arranged in such a way that the power is restored when the emergency stop pushbutton is restored to its normal position, no reset or other intervention is required. All estop shall be shrouded to reduce the risk of accidental activation.

9. Electromagnetic Interference, Radio frequency Interference, Disturbances and Harmonic Limitation.

The designer shall prevent interference to equipment and services. Limit interference, disturbances and distortion in accordance with relevant codes and standards including the following standards:

- AS/NZS 61000 Electromagnetic capability
- AS/NZS CISPR Limits and method of measurements of radio Disturbance characteristics of electrical motor operated and thermal appliances for households and similar purposes, electrical tools and similar electrical apparatus.

All devices supplied, including drives, variable speed drive (VSD), motors, appliances, wiring and the like.

All devices shall comply with the mandated standards in the EMC framework issued by the Australian

Communications Authority (ACA) or Australia Communications and Media Authority (ACMA), with the State Electricity Distribution Codes, the Statutory Regulations contained in the State Service and Installation Rules and with IEEE Standard 519 and AS/NZS 61000.3.

Where devices are likely to be incompatible with emission levels, power quality, etc., they shall be provided with suitable filtering and conditioning equipment to ensure correct operation in the environment encountered and compliance with the above standards.

All required devices used shall have a C-Tick label that has been registered with the ACA.

10. Voltage Drop

In accordance with AS/NZS 3000, the maximum permissible voltage range at any point in an electrical installation under normal service conditions, excluding voltage transients such as those due to system switching, shall be 400/230V +10% 11%. This is based on the nominal supply voltage of 400/230V +10% 6% and the maximum permissible voltage drop between the point of supply and any point of an electrical installation of 5%.

The designer must determine the supply system characteristics which shall be accounted for in the electrical distribution system design to ensure the voltage is maintained within the above voltage range. In determining the voltage drop, a minimum 25 percent load growth allowance or suitable master planned load allowance, whichever the greater, shall be used in addition to the estimated maximum demand.

Transient voltage performance (where outside the above voltage range) needs to be checked against the facility or equipment requirements to ensure the correct operation of the installation and equipment. Where equipment is susceptible to voltage transients the designer must ensure that the electrical installation is designed to meet the equipment requirements.

In determining the voltage drop the designer shall consider:

- Use of the electrical installation.
- Any special equipment requirements.
- Location and distribution of the load. Location and arrangement of the loads dictate the requirement for additional distribution boards.
- Characteristics of the load such as the effect of motors and effect of fluorescent or discharge lighting.

Adequate allowance is required to cater for transient performance. The effect of low power factor and switching transients and impact of high current draw need to be adequately catered for and may require dedicated submains and distribution boards.

11. Circuit Arrangements and Spare Capacity

The designer is to review all equipment and user requirements in determining the most appropriate and cost effective electrical distribution layout. Adequate spare capacity is required as follows:

Switchboards

- 25% spare capacity.
- 25% space for additional switchgear.

Consumers Mains and submains

- 25% spare capacity.

Power circuits

- Maximum 12 double socket outlets per circuit with a minimum 30% spare capacity.

Lighting circuits

- Maximum 66% utilisation (i.e. 33% spare capacity).
- Minimum 2.5mm2 cabling.

Control Wiring

- All control wiring is to be uniquely numbered and ferruled. A schematic diagram that complies with UON specification UON-DSS-001 CAD Drafting Standards shall be provided for all control wiring.

Cable trays and ducts

- 50% spare capacity.

Conductor Colours

- Phases are to be either Red, White or Blue.
- Neutral conductors are to be Black.

Kitchen Wiring

- No more than two outlets per circuit on kitchen benches.

Dedicated power circuits shall be provided for equipment loads. Where appropriate the designer shall consider the installation of distribution boards for the connection of the equipment. As a general rule dedicated circuits shall be provided for the following:

- Each communication equipment rack.
- Lighting.
- General power.
- Electrical equipment.
- HVAC/mechanical services.
-

Care shall be taken to limit the number of points on a circuit and to distribute the points with leakage current in order to avoid nuisance tripping.

Power requirements can be deduced from the respective room data schedules.

Where multiple cables enter an enclosure through a single compression gland, the gland shall to be sealed to maintain IP rating. Tightening of the gland to compress on the cables is not a sufficient seal.

ELCBs shall be provided to all lighting and power circuits as required by Australian Standards.

12. Selection of Equipment

All electrical equipment in an electrical installation (i.e. cables, accessories, appliances, switchgear, control gear and the like) shall be suitable for use which encompasses safety from shock, prevention of injury and prevention of any adverse effect in accordance with AS/NZS 3000. UON-ESS-105 shall be used as a guideline for equipment purchase.

12.1. Location of Equipment

Equipment shall be installed to minimise the risk of injury to the users or damage to the equipment. All electrical equipment, including light switches and GPO's, shall have a minimum separation distance of 300mm from any cooktop or other heat producing device.

All motors above 4kW shall have a local lockable isolator within 2 meters of the motor.

13. Switchboards

All buildings shall be provided with a dedicated Main Switchboard with a single dedicated supply mains from the substation LV switchboard located within the substation.

Dedicated submains shall be provided to all individual distribution boards within the building. Rising mains feeding multiple DBs will not be acceptable. Mechanical Services are to be fed from the MSB only.

The location of the main switchboard shall be readily accessible from the entry of the building. Main switchboards require special consideration since in an emergency situation such as a fire, the switchboard will need to be located and operated by persons unfamiliar with the installation and the disposition of the equipment on the switchboard. This requires the main switchboard for a building to be located within easy access to the entrance of a building with its location clearly indicated at the main entrance, by a sign if necessary, and at the fire indicator panel.

All switchboards shall comply with AS/NZS 3000 and AS 3439 series of standards. Main switchboards shall be at least Form 4a construction. Distribution boards shall be Form minimum 2bi construction.

The finish and IP rating of switchboards shall be in accordance with the environment in which the board is installed. In harsh environments consideration shall be given to using marine grade aluminium or stainless steel enclosures. All switchboards shall be provided with locks wherever possible and all switchboards shall be dead front type and provided with doors. Lift-off escutcheon panels are not permitted.

LV switchboards should be fitted with a bus tie arrangement to allow for transformer maintenance without the need for power interruption.

If a DB is to be integrated into the MSB it shall have a dedicated main switch to provide isolation of the entire DB cubicle to allow work to be undertaken within the DB without isolating power to the MSB. All MSBs and distribution boards shall be housed in lockable rooms or cupboards to allow access to authorised personnel only.

All DB's shall have separate light and power chassis. Each chassis shall have separate metering. A dedicated feed from the MSB will be provided to the MSSB. Sub MSSBs shall then be fed from the MSSB if required. The main feed to the MSSB shall have a separate energy meter.

Refer to:

- UON-ESS-102 Distribution Board Specification
- UON-ESS-112 Main Switchboards Specification

14. Residual Current Devices

Residual Current Devices shall be incorporated into the facilities in accordance with the requirements AS/NZS AS3000:2007.

15. Power Factor Correction

Power factor correction shall provide at the Authority connection point. This may be HV or LV power factor correction or the augmentation of existing power factor correction to maintain a minimum power factor of 0.96 lagging.

PFC Units shall have automatic control with suitable capacitive steps (minimum of 5) to provide stable control of the power factor. Duty cycle of the steps shall be controlled to prevent unequal duty of the small capacitor stages. The designer shall ensure any power factor correction is designed with capacitive steps suitable to the size of the load and has spare capacity for a minimum of 20% additional capacity.

16. Lightning Protection

The designer shall investigate the requirement for lightning protection. Lightning protection, where provided, shall be designed and installed in accordance with AS/NZS 1768. The following facilities shall be provided with lightning protection irrespective of the assessment:

- Where the facility type of construction allows lightning protection to be installed or incorporated at little cost (e.g. fully metallic construction).
- Alternate protection schemes shall be considered such as single point sphere or copper strap down conductors connected to a single earth (separated as far as possible form building systems and services). The preferred protection scheme shall be approved by IFS.

All computer accommodation and other sensitive equipment shall be provided suitable surge, inline filters and transient protection.

Surge protection shall be installed on the incoming supply within all Main Switchboards and distribution boards and selected from the approved suppliers list.

17. Metering

An intelligent metering system incorporating MDIs, voltmeter, ammeter, power factor, kW, kVA and kWh functions shall be provided at every substation on the output of the transformer.

An intelligent meter shall also be provided for each new facility in addition to the requirements of Section J of the BCA. The preferred location for this metering is at the substation to minimise control cabling, however for large facilities with multiple meters install the meters at the facility. Where a substation supplies only one significant facility the additional meter for the facility can be omitted.

Refer to:

- UON-ESS-102 Distribution Board Specification
- UON-ESS-112 Main Switchboards Specification

Connection of gas and water metering to the energy monitoring system shall also be required. All meters shall be located in an area that is accessible from ground level and does not require the use of a ladder to access.

Meters must be compatible with the existing energy monitoring system and set up so that they are added to and configured in the existing energy monitoring system.

18. Labelling

All field electrical devices or equipment connected to a Distribution Board, Load Centre, Main Switchboard or any other electrical supply shall include a label identifying the origin of the circuit. These devices include, but are not limited to, GPO's, SPO's, Switch plates, Light fittings, motion detectors, Daylight switches or any junction box or enclosure intended to contain live electrical components. The label shall include the Name of the board and Circuit from which the supply originated. For example, a GPO fed from Distribution Board No.4, Circuit Breaker 16 would display a label "DB4 CB16".

The label shall be engraved and mechanically affixed to the device. Alternatively, engraved adhesive labels can be used if the identification is also written in permanent marker behind or inside the device. With a GPO or Lighting Switch plate this would mean the DB and circuit number written on the back of the plate facing the wall.

19. Height Adjustable Desks

The layout of power outlets on height adjustable or Sit/Stand desks should reduce the need for EPOD's (Power Boards) once the desk is in service. There shall be a minimum of four static 240V outlets below the desk. There shall also be two 240V and two USB outlets mounted above/on the desk. One only of the outlets below the desk may be used to supply the height adjustment mechanism or the outlets above the desk. The desktop outlets shall be angled at a minimum of forty five degrees to the horizontal plain to reduce the accumulation of dust and liquids. The outlets shall be fixed in position and arranged in such a way that the outlet cables are not pinched or mechanically stressed during the raising and lowering of the desk.

20. Handover of New Works/Commissioning

The designer shall acquaint themselves with the university access and operating requirements and make all necessary allowances in the design. In particular the designer must ensure that appropriate requirements and associated costs are included to address the following:

- Access permits, vicinity permits, dig permits, etc.
- Requirement for the contractor to have all necessary skills and training such as recipient training.
- Requirement for standard keying arrangements.
- Access to the high voltage systems including method of works and constraints in opening the high voltage system or any configuration changes effecting continuity of supply either directly or by subsequent fault.
- Required commissioning and acceptance procedures for new installations including the completion of all required tests and proving the system is safe to the requirements of the operating authority before connection.
- Requirements of Ausgrid.

The staging of the works shall ensure that where the high voltage system is opened, the duration of the outage is as short as practical. Under no circumstances shall the reticulation system be left with an open ring for greater than three days and all such works require prior approval from the Infrastructure & Facilities Services representative.

Before Infrastructure & Facilities Services can accept any new equipment for connection to the high voltage system and the designer must ensure that the following minimum requirements are documented as an obligation of the Contractor:

- All required tests have been undertaken and compliance certificates of Infrastructure & Facilities Services such as (but not limited to) earth mat resistance tests, high voltage withstand tests and polarity tests.
- All switchgear and equipment is correctly labelled and that the new labels for the existing reticulation are ready for change or changed as required by the Infrastructure & Facilities Services.
- All required safety equipment is provided, including all signs and barriers.
- Where new equipment is installed all appropriate operating and maintenance information is provided, including the requirement to train the operators where necessary in the operation of the new equipment prior to connection of the equipment.
- Revised documentation, acceptable to the Infrastructure & Facilities Services and reflecting the new system arrangement are provided.
- The new installation has been certified by the contractor as meeting the requirements of all appropriate legislation and standards and the requirements of the design brief.

Before any testing commences, ensure that all equipment likely to be damaged by such testing has been removed from the circuit under test, or has been isolated and earthed. For example: dimmers, lighting controllers, electronic components and the like. All system voltages must be checked to confirm that their magnitude and type is compatible with the interconnected components. All testing and verification must be completed as required by AS3000, particularly Section 8.
Insulation resistance tests must be carried out on all LV main switch boards, LV distribution boards, LV cables and auxiliary equipment as follows:

- The test voltage shall be applied to each conductor and the resistance recorded.
- Voltage rating of insulation testers shall be 500V for LV equipment.
- Acceptable minimum resistance value is 1 MΩ.

On failure of a resistance level test, investigation and rectification works must be completed prior to energisation.

Check that all installed cable sizing complies with the requirements of AS3008.1, AS300 and the Service Rules of the Local Supply Authority.

The contractor must carry out the following:

- Check all relays, contactors, controllers, switches, and push buttons for operation, correct installation, adjustment, rating and labelling
- Check all circuit breakers, fuses, type and rating and compare with specification and schematic diagrams
- Primary Injection tests on all protection equipment
- Check tightness of cable terminations, and correct labelling of all cables, cores and termination strips where required
- Energise lighting and general purpose outlet circuits one at a time. Check that each item is energised by the correct circuit in accordance with the electrical schematic. Check that lamps operate and replace as necessary. Check each power outlet for correct voltage and correct polarity of the device. Check all switches for correct operation
- Complete a neatly typed schedule for each distribution panel and insert inside the panel in door storage provided
- Carry out night test on external lighting to ensure correct lux levels and realign luminaries as necessary.

Complete all others tests as detailed in AS3017 “Electrical Installations – Testing and Inspection Specification.” Use the latest issue of the drawings during pre-commissioning. Mark any drawing changes up neatly using a red pen, and submit to drafter for modification. Provide all final, “as wired” drawings at commissioning.

Check continuity of static earthing throughout all steel work within the installation. All earth resistance testing must be completed using and an approved test instrument, and carried out in accordance with the requirements of AS/NZS 3000 Part 1 before and after the installation is bonded to the grid. Resistance readings shall be recorded and shall not exceed one ohm (1Ω) for the earthing system.

On completion of all checks and testing, ensure that all equipment that has been disconnected and/or removed to enable such checks and testing to be carried out has been replaced and/or reconnected. For example, verify that all links have been closed and tightened, all fuses replaced, all terminations made and tightened, components replaced and/or reconnected, and all covers and the like replaced. The contractor must submit the Certificate of Compliance – Electrical Work (CCEW), covering all installation work, to the Local Electricity Distributor. As well as supplying the CCEW, the person who conducted all testing must submit test reports certifying the electrical installation.

All grading curves results must be submitted for circuit breakers and fuses.

After completing each test outlined in AS/NZS3000 Section 8, the contractor must provide a checklist confirming that each test has been undertaken and successfully completed. This must be signed by the certifying officer. All these documents must be included in the Operation and Maintenance manual (O&M), and submitted to the UoN project manager upon completion. The completed checklist should be supplied to the UoN project manager or Electrical Operations engineer at least 5 days before recommissioning where practicable.

20.1. Handover documentation

Handover documentation for electrical installations shall document the location of all newly installed electrical equipment and the electrical configuration of all associated wiring.

Below are minimum documents for specific installations:

20.1.1. Distribution Boards

- Maximo New Equipment Entry sheet.
- Photo of front of DB
- Electronic copy of legend
- Photo of escutcheon
- Photo of DB Open
- DB General Arrangement Drawing
- Schematic wiring diagram of control circuitry.
- Single Line Diagrams
- Power Meter Manuals
- Surge protection Manuals
- Main CB Settings

20.1.2. Main Switchboards

- Maximo New Equipment Entry sheet.
- Photo of front of MSB
- Electronic copy of legend for any DB section
- Photo of from of MSB
- MSB General Arrangement
- Schematic wiring diagram of control circuitry.
- Single Line Diagrams
- Power Meter Manuals
- Surge protection Manuals
- Main CB Settings
- Manuals for all configurable equipment.

20.1.3. Lighting and General Small Power Installations

- Power layout drawing
- Lighting Layout drawing
- Data Layout drawing
- Photometric drawing showing new light levels
- Maximo Configuration sheets
- Light fitting Specifications
- Lighting control philosophy
- Emergency and Exit lighting compliance.
- Updated DB legend
- GA showing all cast in slab electrical ducting.
- New Maximo items and Maximo Entry sheet.

20.1.4. Generator Installations

- Maximo New Equipment Entry sheet.
- Single line diagram of installation
- Control Wiring external to the generator
- Controller Manual
- ATS Manual
- Generator GA
- Generator Spec sheet
- Full set of generator equipment manuals.

Any modifications to the UoN electrical system shall include an update of associated electrical drawing to UoN drafting standards.

21. Appendix A

UON-ESS-101 General Electrical Specification
UON-ESS-102 Distribution Board Specification
UON-ESS-103 External Lighting Spec
UON-ESS-104 Emergency Escape Lighting and Illuminated Exit Signage
UON-ESS-105 Preferred equipment list
UON-ESS-106 Generators
UON-ESS-113 High Voltage Substations
UON-ESS-111 Interior Lighting and Control
UON-ESS-112 Main Switchboard Specification.
UON-ESS-109 Supply and Installation of Photo Voltaic array
UON-DSS-001 CAD Drafting Standards