Electrical Services

Design Standard

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TAFE NSW would like to pay our respect and acknowledge Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of the Land, Rivers and Sea. We acknowledge and pay our respect to the Elders; past, present and emerging of all Nations.

TAFE NSW Granville Electrotechnology Workshop

Rev	Issue date	Issue	Amendments since previous issue
A	20 August 2021	Draft	
B	01 Sept 2021	Draft for reference	As per comments
C	17 December 2021	Final	Accessibility Review

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This document is a design standard only. The project team retains responsibility for the coordination, design, procurement and delivery of furniture which will include taking all reasonable steps to make sure that the furniture selection complies with all applicable Australian Standards required by the NCC, WHS Legislation, Statutory planning approval processes, TAFE NSW Procedures & Policies, and all other relevant statutory requirements.

TAFE NSW Wetherill Park

Contents

Introduction

1 Introduction

1.1 Overview

This document forms part of the TAFE NSW ITN Design Book and is to be read in conjunction with the overarching design principles described in the TAFE NSW ITN Design Principles, the TAFE NSW ITN Design Procedures and other relevant TAFE NSW Design Standards.

This Design Standard provides specific guidelines for the planning, design, operation and maintenance of electrical systems design within built environment projects across TAFE NSW.

This Design Standard applies to a variety of physical environments including but not limited to new buildings, refurbishments, or a cluster of learning areas or spaces within existing or new buildings.

1 Introduction

1.2 Audience

The diagram below broadly defines the diverse audience this Design Standard is written for and the roles they play through the design, selection and delivery process.

Who should use this Design Standard

Consultants & Contractors

Architects

Interior Designers

Engineers

Project Managers

Construction Contractors

TAFE Project Team

Program Managers

Design Managers

Strategic Planning

Procurement

Facility Management

Sustainability

Logistics

Systems Group

Operations & End Users

Teaching Staff

Education Planning & Services Delivery

Student Experience Group

Product Group

Change Management

Student support groups

Industry Partners

Suppliers

Electrical system suppliers

Electrical system manufacturers

How this Design Standard could be used

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Design and develop electrical systems to suit project needs and meet the requirements of this Design Standard

Consult with the TAFE NSW project team, stakeholders and end users

Manage any sub-consultants or sub-contractors to deliver the electrical design in accordance with this Design Standard and the project brief

Understand electrical design strategies & how electrical equipment can contribute to learning, teaching and timetabling

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Manage the design and development of electrical systems to suit project needs

Assist with project electrical briefing requirements

Manage the design consultants and contractors to deliver the electrical design in accordance with this Design Standard

Review the electrical design & deliverables to ensure compliance with this Design Standard

Guide project stakeholders through design development & facilitate collaboration with electrical designers

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Understand electrical design requirements and assist in developing the brief for specialist electrical systems

Collaborate with electrical designers and provide feedback on electrical designs

Understand design principles & how electrical equipment can contribute to learning, teaching and timetabling

Understand the electrical equipment and wiring requirements to meet future teaching delivery needs

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Understand TAFE NSW requirements for electrical systems

Provide advice to project or electrical designers regarding products or systems that comply with this standard

1 Introduction

1.3 Standards & Documents

The following standards and documents, as relevant to the project, should be read in conjunction with this Design Standard when designing, documenting & delivering electrical systems. This list is not exhaustive and other documents may apply.

1.3.1 External Requirements

Statutory Requirements

The planning and design must incorporate the relevant requirements as stipulated by the following Statutory Authority bodies:

- State Environmental Planning and Assessment Legislation
- All Commonwealth, State and Local Government Legislation
- Any conditions of consent identified through the statutory approvals process
- Insurance Council of Australia
- Fire & Rescue NSW
- Australian Communication Authority
- National Construction Code/Building Code of Australia
- Principal Certifying Authority (person qualified to conduct a Certification of Crown Building Works)
- Electricity Distributor's (Network) Requirements
- Electricity Retailer's Requirements
- NSW Wiring and Installation Rules
- Clean Energy Council
- Work Health and Safety Act
- Disability Discrimination Act
- Safe Work NSW Authority Requirements
- Any other authority having jurisdiction

External Certification Schemes

- Green Building Council of Australia (GreenStar) and other recognised certification schemes (eg. GECA, etc)

NSW Government Policies

- Workplace Design Principles (NSW Department of Planning, Industry and Environment)
- NSW Government Electric Vehicle Strategy
- NSW Climate Change Policy Framework
- Better Placed - Design objectives for NSW (Government Architects NSW)
- NSW Government Resource Efficiency Policy (GREP)
- NSW Government Net Zero Plan Stage 1 2020-2030

1 Introduction

1.3 Standards & Documents

1.3.2 TAFE NSW Requirements

TAFE NSW Interconnected Training Network Design Book

- Interconnected Training Network Design Principles
- Interconnected Training Network Design Procedures
- Other Design Standards relevant to project

TAFE NSW Policies

- Environmental Sustainability Policy
- Reconciliation Action Plan
- Diversity and Inclusion Policy
- Work Health and Safety Policy
- Disability Inclusion Action Plan and Implementation Guide

1 Introduction

1.3 Standards & Documents

1.3.3 Standards

The following Australian and New Zealand standards must be incorporated within the electrical services design:

Code Standards	Description
Australian Standard AS 1428.1 & 1428.2	Design for access and mobility
Australian Standard AS/NZS 3012	Electrical Installations - Demolition and Construction Sites
Australian Standard AS/NZS 3000	Wiring Rules
Australian Standard AS/NZS 3008	Electrical Installations - Selection of Cables
Australian Standard AS/NZS 3001	Electrical Installations - Transportable structures and Vehicles including their site supplies
Australian Standard AS/NZS 3013	Electrical Installations - Wiring Systems for Specific Applications
Australian Standard AS/NZS 3017	Electrical Installations - Testing and Inspection Guidelines
Australian Standard AS/NZS 61439.1	Low Voltage Switchgear and Control gear Assemblies Part1
Australian Standard AS/NZS 61439.2	Low Voltage Switchgear and Control gear Assemblies Part2
Australian Standard AS/NZS 61009.1	Residual current operated circuit breakers with integral overcurrent protection for household and similar uses (RCBOs)
Australian Standard AS/NZS 3190	Approval and Test Specification - Residual Current Devices
Australian Standard AS/NZS 3131	Plugs and Socket Outlets for use in Installation Wiring Systems
Australian Standard AS/NZS 3100	Approval and Test Specification - General requirements for electrical equipment (Parent specification for essential safety requirements)
Australian Standard AS/NZS 3112	Approval and Test Specification - Plugs and Socket Outlets
Australian Standard AS/NZS 3760	In-service Safety Inspection and Testing of Electrical Equipment
Australian Standard AS/NZS 60065	Audio, Video and Similar Electronic Apparatus - Safety Requirements
Australian Standard AS/NZS 60529	Degrees of protection provided by enclosures (IP Code)

1 Introduction

1.3 Standards & Documents

Code Standards	Description
Australian Standard AS/NZS 61000.6.1	Electromagnetic Compatibility (EMC) - General standards: Immunity for Residential, Commercial and Light Industrial Environments
Australian Standard AS/NZS 61000.6.2	Electromagnetic Compatibility (EMC) - General standards: Immunity for Industrial Environments
Australian Standard AS/NZS 61000.6.3	Electromagnetic Compatibility (EMC) - General standards: Emission Standard for residential, Commercial and light-industrial environments

1 Introduction

1.4 Definitions

1.4.1 Abbreviations

Abbreviation	Description
AFFL	Above Finished Floor Level
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
ASP3	Level 3 Accredited Service Provider
ATS	Automatic Transfer Switch
BMCS	Building Management and Control System
CO^2	Carbon Dioxide
CT	Current Transformer
DB	Distribution Board
DBYD	Dial Before You Dig underground search
DIN	Switchboard industry standard rail mounting system for control and metering equipment
DSSO	Double Switched Socket Outlet
ELF	Extra Low Frequency
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMSS	Energy Management System Software
EMS	Energy Management System
EV	Electrical Vehicle
EPO	Emergency Power Off
GUI	Graphic User Interface
HDUPVC	Heavy Duty Underground PVC
IP	Ingress Protection rating is a numerical two digit code to indicate the degree of dust and moisture provided by an enclosure of electrical switchboard, outlets or the like equipment
ITN	Interconnected Training Network
LV	Low Voltage
MEN	Main Earth Neutral
MSB	Main Switchboard
MSSB	Mechanical Services Switchboard

1 Introduction

1.4 Definitions

Abbreviation	Description
MDB	Main Distribution Board
MTS	Manual Transfer Switch
MV/LV	Medium Voltage/Low Voltage
NMI	National Metering Identifier
NTTA	National Association of Testing Authorities
NCC	National Construction Code of Australia
QA	Quality Assurance
PV	Photovoltaic
RCBO	Residual Current Circuit Breaker with Overcurrent Protection
RCD	Residual Current Device
SLD	Single line Diagram
SSO	Switched Socket Outlet
UPS	Uninterruptable Power Supply
USB	Universal Serial Bus
WHS	Workplace Health and Safety

1 Introduction

1.4 Definitions

1.4.2 Terms

Terms	Description
Supply	"Supply", "furnish" and similar expressions mean "supply only"
Provide	"Provide" and similar expressions mean "supply, install and commission"
Approved	"Approved", "reviewed", "directed", "rejected", "endorsed" and similar expressions mean "approved (reviewed, directed, rejected, endorsed) in writing by the TAFE NSW appointed delegate"
Give notice	"Give notice", "submit", "advise", "inform" and similar expressions mean "give notice (submit, advise, inform) in writing to the TAFE NSW appointed delegate"
Obtain	"Obtain", "seek" and similar expressions mean "obtain (seek) in writing from the TAFE NSW appointed delegate"
Proprietary	"Proprietary" mean identifiable by naming manufacturer, supplier, installer, trade name, brand name, catalogue, or reference number
Samples	Includes samples, prototypes and sample panels
This Design Standard	TAFE NSW Electrical Services Design Standard

Applications

2 Applications

2.1 Scope

2.1.1 How This Design Standard Applies

Compliance

This Design Standard is intended to support and assist the selection, design and procurement of electrical systems.

This Design Standard must also be read in conjunction with:

- Statutory and legislative requirements
- Contractual Agreement with TAFE NSW
- The Project Brief and relevant project requirements
- Any other TAFE NSW Design Standards

Where there is a conflict between this Design Standard and any statutory or legislative requirement, the higher standard applies.

Mandatory/Must

Where the word “must” is used, this indicates that a statement is mandatory.

Preferred/Should

Where the word “should” is used, this indicates that a statement is a recommendation.

Contractual Responsibility

The contents of this Design Standard does not relieve any consultant, contractor or supplier from their contractual responsibility relevant to the project.

It remains the responsibility of the consultant, contractor or supplier to fully complete, coordinate and identify any errors or omissions in the documentation produced for the electrical design.

Queries

Any project specific queries are to be raised through the TAFE NSW project lead, or project manager as applicable.

If this document appears to contradict or deviate from good industry practice or any statutory requirements, this is to be brought to the attention of the TAFE NSW project lead responsible for the delivery of the electrical design project.

2 Applications

2.1 Scope

2.1.2 Electrical Systems Covered By This Standard

This standard outlines the general electrical services scope as follows:

1. Liaison with ASP2 and ASP3 design planning for substation infrastructure
2. Campus main switchboards and building main distribution boards
3. Distribution boards and load centres
4. Supply authority and TAFE NSW energy monitoring
5. Power factor correction and active harmonic filtering
6. Alternative power supplies – generator, UPS, photo voltaic, batteries
7. Consumer mains, submains, sub-circuit, control and interface wiring
8. Outlets, isolators, control devices, connections and operating devices
9. Campus underground conduit routes and pits
10. Building reticulation pathways
11. Lightning and surge protection
12. Earthing and equipotential bonding
13. Electromagnetic interference

2.1.3 Other Electrical Systems

In addition to general electrical design covered by this Design Standard, electrical designers must liaise, consult and collaborate with TAFE NSW stakeholders and user groups to include specific electrical design, operation and maintenance requirements for the following faculty specialist areas:

1. Engineering and electrotechnology systems
2. Welding, fitting, machining, metal fabrication, carpentry and other building services trades
3. Hospitality and food preparation
4. Laboratory, and science preparation
5. Nursing, dental, allied healthcare and research areas
6. Photography and film, TV, digital media
7. Vehicle painting, automotive trades
8. Printing, graphic arts
9. Watchmaking and detailed working
10. EDI/theatre spaces
11. Horticulture/greenhouses
12. Dangerous goods and hazardous material storage areas
13. Visual merchandising and retail tenancies
14. Multiple use learning spaces
15. Any other specialist faculty or learning areas not covered by this Design Standard

2 Applications

2.2 Project Application

2.2.1 Project Types

This design standard is intended to support the electrical services design and delivery of a variety of physical environments including but not limited to the project types below:

Major Capital Works & Special Projects

1. All new building and major refurbishment projects must comply with this design standard
2. Switchgear, metering, outlets, equipment must be consistent throughout the entire building project
3. All existing electrical switchboards, associated wiring and cable management infrastructure must be assessed for suitability, capacity (including spare capacity) and compatibility with new works. Where assessed as not suitable, replace with new

Minor Works

4. All buildings alterations and additions must comply with this standard
5. Switchgear, metering, outlets, equipment must be consistent throughout the entire project fitout area. Every effort should be made to integrate the fitout with the adjoining areas
6. All existing electrical switchboards, etc and associated wiring and cable management infrastructure augmented, altered or modified or must be assessed for suitability, capacity (including spare capacity) and compatibility with new works. Where assessed as not suitable, replace with new

Mini-Minor Works

1. All minor fitouts should make every effort to comply with this standard
2. Outlets and equipment must be consistent throughout the entire project fitout area. Every effort should be made to integrate the fitout with the adjoining areas
3. Utilise spare capacity available or provide additional modules to connect to existing electrical distribution switchboards, associated wiring and cable management infrastructure . Provide additions and modifications that are compatible and of suitable capacity to accommodate proposed project requirements

2 Applications

2.2 Project Application

2.2.2 Project Stages

This Design Standard is to be used for the whole life cycle of the project. Depending on the user and project type, the requirements in this Design Standard will be used in all or only select stages.

2.2.3 Project Designer

The electrical designer or consultant must be an experienced and suitably qualified electrical services designer covered by professional indemnity and public liability insurance in accordance with the TAFE NSW contract and relevant industry requirements.

At the completion of the briefing stage and at every design stage, the electrical designer must obtain endorsement of the proposed design from the TAFE NSW project team to proceed to the next stage.

In addition to the project deliverables, the electrical designer has the following obligations:

- Review of all documents and specifications provided by the installer to maintain quality of the installation in accordance with the design
- Review of samples provided by the installer to maintain quality of the installation in accordance with the design

2.2.4 Project Installer

The electrical installer or contractor must be an experienced and suitably qualified electrical services designer covered by professional indemnity and public liability insurance in accordance with the TAFE NSW contract and relevant industry requirements.

At the completion of every design stage, the electrical installer must obtain endorsement of the proposed design from the TAFE NSW project team to proceed to the next stage.

In addition to the project deliverables, the electrical installer has the following obligations:

- To provide detailed on-site measurement, co-ordination with building elements and other services to establish final set-out, location of equipment allowing for maintenance access envelope requirements
- To provide detailed programs including milestones indicating shutdowns, temporary requirements to maintain occupancy, staging of works and commissioning prior to handover
- To provide manufacturer's workshop, equipment specifications and construction drawings, schedules and details

2 Applications

2.3 Project Design Documents

2.3.1 Designer Deliverables

The electrical designer or consultant must prepare and submit all reports, design documents and certification as required to fully describe the design and to suit the scale and complexity of the project. The minimum documentation is as indicated below:

Site investigation and audit report must include:

A detailed site investigation and audit must be undertaken for the entire existing electrical services including substation, alternative power supplies, switchboards, equipment, controls, cabling and associated cable management. This must include:

1. An assessment of the condition, available spare capacity and compatibility for the intended existing equipment and/or system and whether it is suitable for re-use
2. A due diligence review of any non-conformances to any applicable standards and authority requirements
3. List all non-compliance items with TAFE NSW standards and/or any other reference documents provided
4. Any site constraints, potential hazards or risks
5. An outline of the findings, outcomes and recommendations

Return Services Brief must be prepared and submitted to include:

1. Identify and qualify the strategic deliverables to be achieved
2. Incorporate all site audit investigation findings and outcomes
3. Indicate demolition, disconnection, making safe, dismantling and de-commissioning of existing redundant systems
4. Identify site storage, disposal and removal of redundant equipment and their associated control and wiring requirements
5. Outline staging of works in accordance with the construction deliverables satisfying stakeholder and user group requirements
6. Investigate temporary construction supply requirements and indicate the origin, ability to maintain reliability and availability of the supply serving the buildings affected
7. Ensure all electrical services location and spatial considerations including maintenance envelopes, access to equipment and egress requirements of switchbards, switchgear, metering, outlets and control equipment, are considered and incorporated within layouts
8. Outline findings identified as part of TAFE NSW stakeholder consultation and all other design consultant input for electrical services to be provided for each specific area
9. Identify Green Star metering initiatives and their design requirements
10. Outline spare capacity and modular additions including spatial considerations
11. Outline coordination of all electrical services demarcation with interfaces and in connection with other trades
12. Nominate sample submission requirements and applicable warranties of proposed equipment
13. Describe a comprehensive labelling methodology
14. Confirm compliance with mandatory standards and regulatory authorities

15. Confirm compliance with this Design Standard and any other relevant TAFE NSW standard
16. Identify where there is any ambiguity, conflict or discrepancies and highlight these within the return services brief

Budget Cost Summary must be prepared and submitted identifying costs for all electrical services systems at each specific area in accordance with the return services brief. Outline any assumptions and exclusions.

Any proposed alternate innovative electrical design solutions must undertake a cost/benefit analysis study. This must identify capital costs, ongoing energy and maintenance costs, along with a qualitative analysis illustrating the reliability, longevity, and maintenance regime for the alternative proposal. Offer a fair, comparative assessment of the capital and operational costs of this alternative solution when compared with the applicable specified provisions.

Design Calculation Report must be prepared and submitted identifying electrical services design criteria provided, maximum demand calculations, fault level calculations, volt drop and loop impedance calculations, cabling configuration and installation methodology and associated control methodology.

Risk Management Report must be prepared and submitted identifying:

1. Safety and design requirements for construction, operation and maintenance
2. The origin of all identified risks
3. Work to be carried out in hazardous and confined spaces
4. Asbestos retention and/or removal
5. Hazardous goods handling and storage areas
6. Any specific stakeholder insurance risk requirements
7. Potential latent conditions including the process for early resolution to agree costs involved prior to proceeding with works and to avoid/ mitigate construction delays

Certification must be submitted to the Principal Certifying Authority/person qualified to conduct a Certification of Crown Building Works in accordance with the NCC/BCA, statutory and regulatory authority requirements, this Design Standard any other relevant TAFE NSW standard.

2 Applications

2.3 Project Design Documents

Specification Documentation must incorporate and further develop the detail of the electrical services design including requirements of all relevant report findings and outcomes, along with the inclusion of the following as a minimum:

1. Address the design principles and strategies of this Design Standard
2. Address the project specific design strategies
3. A comprehensive project specific scope of electrical services systems, schedules of cabling and equipment and all associated technical requirements
4. Detailed demarcation requirements of the interface and associated works
5. Be compliant with this Design Standard, all other relevant TAFE NSW standards, all statutory and regulatory authority requirements in accordance with certifications provided
6. Be co-ordinated with the latest reference documents and each trade services design input
7. Commissioning, testing and quality monitoring framework during the construction works
8. TAFE NSW staff training and handover procedures
9. Identify working and final documents and record requirements
10. Identify a comprehensive Operating and Maintenance Manual requirements

2.3.2 Installer Deliverables

The electrical installer or contractor must prepare and submit all reports, design documents and certification as required to suit the scale and complexity of the project. The minimum requirements for deliverables are as indicated below:

Samples: Submit all specified electrical services outlets, equipment and associated devices, switches and panel samples and any installer proposed alternative samples for review and comparison by the design team.

Alternative Design Verification: Where alternatives are proposed, provide an alternative design assessment report indicating compliance with the electrical design intent and design criteria. Provide all supporting technical data, and associated installation methodology which must be compliant with statutory requirements.

Risk Management Report is to be prepared and submitted identifying:

1. Safety in Design requirements for construction and installation
2. The origin of all identified risk
3. Any potential electrical hazards
4. Any work to be carried out in hazardous and confined spaces
5. Asbestos retention and/or removal
6. Hazardous goods handling and storage

Interruption of Supply notices: Notice of interruption of supply is to be submitted for acceptance when undertaking any planned interruption of supply to existing areas of an occupied building.

2 Applications

2.3 Project Design Documents

Commissioning and Testing: The electrical contractor must develop and submit a project specific commissioning and testing plan in accordance with their quality assurance plan. This must be consistent with the builder's construction program including:

1. All defined handovers including staged areas
2. All milestones
3. Notice for witness upon completion of all acceptance testing and commissioning activities
4. Completion of all mandatory site tests in compliance with standards and authority requirements
5. Detail of testing for each system and associated sub- component
6. All acceptance testing and commissioning records and certificates
7. All commissioning and test reports and certificates indicating observations and results of tests, commissioning and compliance or non-compliance with statutory authority requirements
8. All final and acceptance test records in suitable format for the inclusion in Operating and Maintenance manuals
9. A Twelve month building tuning process must be provided for the power factor correction or active harmonic filtering with commencement at handover to TAFE NSW with systems monitoring monthly reporting from energy management system to be assessed each three month period to include feedback from the TAFE NSW staff
10. All programing back up data for the EMS system

Workshop Drawings: Submit further developed detailed design drawings, addressing method of installation, mounting and fixing, circuiting referencing to circuit breaker termination, switching and grouping address, temporary works and staging, minor alterations in construction, approved value engineering initiatives and alternative designs.

As-built Drawings: Submit revised As-installed drawings, circuiting matching switchboard schedules, illustrating as –installed mounting and fixing details.

Warranties: Submit all extended warranties for installation and equipment as listed in the Technical Requirements section.

Operating and Maintenance Manuals: prepare and submit an operating and maintenance manual with the inclusion of the following project specific detailed requirements:

1. Table of contents: As per contractual requirements
2. Directory: As per contractual requirements
3. Format: As per contractual requirements
4. Installation description: General description of installation
5. Systems descriptions: Technical description of the systems installed, written to ensure that the Proprietor's staff fully understands the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions
6. Systems performance: Technical description of the mode of operation of the systems installed

7. Certificates:
   - Certificates from Authorities
   - Product certification
   - Contractor waterproof sealing of penetrations certificate
   - Contractor fire and smoke sealing penetrations certificate
   - Contractor acoustic sealing of penetration certificate
   - Seismic restraint mounting certification
   - Calibration certificates at acceptance testing and final testing
   - Design certificates demonstrating compliance to TAFE NSW Standards, all statutory & authority requirements, and the NCC
   - Installation certificates to TAFE NSW Standards, all statutory & authority requirements, and the NCC
   - Supply authority completion forms and inspection records
   - Inspection and contractor rectification records
8. Drawings and technical data: As necessary for the efficient operation and maintenance of the installation
9. Equipment descriptions:
   - Name, address, telephone and facsimile numbers of the manufacturer and supplier of items of equipment installed, together with catalogue list numbers
   - Schedules (each switchboard and area type) of outlets and equipment including:
     - Identification locations, metering and control settings, performance figures and dates of manufacture. Provide a unique code (Asset) number
     - Cross-reference to the record and diagrammatic drawings and schedules, including easy to find spare parts schedule, for each item of equipment installed
     - Manufacturers' technical literature for Switchgear, metering and associated controls, outlets, and all other electrical equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each switchboard, meter, outlet, a control device, and the like electrical equipment product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation
   - Generic Brochures are not acceptable. Provide project specific technical data of items installed
   - Mounting and fixing to product data to illustrate relations of component parts. Include typed text as necessary
10. Manufacturer’s product data for proprietary equipment, including:
    - Technical specifications and drawings
    - Verification reports
    - Performance and rating tables
    - Recommendations for installation and maintenance
    - Schedule of proposed major products that are not specified as proprietary items
    - Product certification

11. Operation procedures:
    - Manufacturer's technical literature as appropriate
    - Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure including automatic and manual control override procedures
    - Switchgear, metering and control schedule of settings established at acceptance and final commissioning and testing, making reference to each switchboard
    - Control sequences and flow diagrams for systems installed
    - Compile an electrical services switchgear, metering and control user interface guide to include all operating instructions to enable user to configure equipment to achieve a reliable, energy efficient, safe and fully functional operation

12. Maintenance procedures:
    - Manufacturer's technical literature as appropriate. Register with manufacturer as necessary. Retain copies delivered with equipment
    - Detailed statutory switchboard maintenance testing and recording
    - Safe trouble-shooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, and checking procedures. Provide logical step-by-step sequence of instructions for each procedure
    - Schedule of spares recommended to be held on site, being those items subject to wear or deterioration and which may involve the Proprietor in extended delivery times when replacements are required. Include complete nomenclature and model numbers, and local sources of supply
    - Schedules of equipment, local sources of supply, and expected replacement intervals
    - Instructions for use of tools and testing equipment
    - Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding

13. Records and Documents:
    - All construction drawings shall be revised to ensure inclusion of all additions, modifications and alterations during the construction stage to be submitted as As-built drawings, to same scale and format
    - All fabrication and workshop drawings shall be revised to ensure inclusion of all additions, modifications and alterations during the construction stage to be submitted as As-built drawings, to same scale and format
    - All electrical services system and control schematics, electrical wiring diagrams
    - Switchgear and control gear assembly, metering, circuit and equipment schedules including electrical service characteristics, controls and communications
    - All licensed versions of computerised software required to program and monitor systems

- All security code access, usernames and passwords, configuring, data base and recovery protocols stored in digital format on an external hard drive, required to reset and access all energy management software
- Equipment asset numbered schedules, identifying condition and use with unique label

14. Commissioning and Testing Records
    - Contractors completed self-regulated inspection & test plans for each electrical services system installed
    - Completed logbooks and the like

15. Extended Warranties for:
    - Switchboards(MSB, MDB , DB): 25 years
    - Switchgear, control devices and indication equipment:25 years
    - Surge protection equipment: 25 years
    - Metering system equipment: 25 years
    - Inverters : 7 years
    - PV cell panels: 20 years
    - Batteries: 10 years
    - UPS: 10 years
    - Diesel generators: 25 years
    - Power factor correction: 25 years
    - Active harmonic filters: 25 years

Installation Certification is to be submitted to the Principal Certifying Authority/person qualified to conduct a Certification of Crown Building Works in accordance with design documents, NCC/BCA, statutory and regulatory authority requirements, this Design Standard or and any other relevant TAFE NSW standard.

Design Strategies

3 Design Strategies

3.1 Design Strategies

3.1.1 User Wellbeing

Create a safe environment for occupants with user friendly interfaces that are readily accessible.

Strategy	Requirement
Safety	Identify potential hazards and undertake a risk assessment to implement safe installation, operational procedures and ongoing maintenance methods
Safety	A method of safe access is to be established for electrical services installations for periodic cleaning, repair or replacement of equipment
Accessibility	Create an environment that promotes equitable access for all users regardless of ability. User interface metering, controls and outlets to be accessible and clear from any obstructions
User Interface	Enable easy user-friendly interface with non-technical operating instructions to facilitate intended use

3 Design Strategies

3.1 Design Strategies

3.1.2 Adaptability

Electrical outlets and equipment design to be consistent and compatible, allow multifunction use and future growth requirements.

Strategy	Requirement
Consistency	Ensure consistency of manufacture and model type within adjoining buildings, areas or rooms within the building. Select components which complement the architectural and interior design finishes and address items of heritage significance
Compatibility	Accommodate existing installations including site conditions, building elements, ceiling types, structure and other services penetrations, control and interfacing requirements. Ensure selections are suitable for their intended purpose and the area serviced
Future growth	Allow spare capacity and modular system framework to support future expansion
Multi-function	Location and installation method to allow flexible user operation
Environment	Address the longevity of the installation subject to the environmental conditions of the area such as high ambient temperatures, dust, moisture and/or impact on outlets, equipment and the like
Innovation	TAFE NSW supports innovation across all scales of project delivery. Where a consultant/contractor identifies an opportunity to implement innovative solutions these may be submitted to the TAFE NSW project lead for review

3 Design Strategies

3.1 Design Strategies

3.1.3 Understanding Context

Address the project scope, construction, cost, maintenance, sustainability and quality requirements.

Strategy	Requirement
Project Type	Facilitate the specific project scale, site conditions and campus location
Construction	Resilient and robust construction to allow reliable use within the installed environment
Cost	Undertake a holistic cost-effective design to mitigate procurement, installation, and ongoing maintenance costs and support the longevity of the proposed electrical services installation
Selection	Select components that are readily available from local suppliers
Maintenance	Facilitate ongoing monitoring procedures, and enable installation and maintenance without any access constraints or the need for dismantling or demolition
Sustainability	Incorporate energy saving initiatives that allow the user to monitor energy usage and provide reporting to mitigate operational energy consumption
Quality	Assess, evaluate and verify performance, method of installation, commissioning and testing to meet functional and operational requirements and achieve longevity of the installation in accordance with warranties provided

Technical Sections

4 Technical Sections

4.1 Electrical Supply

4.1.1 Summary

The mains electrical supply should originate from either:

1. Existing spare capacity within the site infrastructure, or
2. The electricity network based upon application to the local network provider for a new:
   - Aerial service mains supply
   - Underground service main supply
   - Kiosk type substation
   - Surface Chamber substation

The following alternative power supplies are typically not required for TAFE NSW sites unless subject to specific stakeholder requirements identified in the project brief:

1. Standby generators
2. Mobile generator facility
3. Uninterruptable power supplies

4.1.2 Design

Design Calculations

Utilise PowerCAD software to validate the design methodology to AS/NZS 3000 and AS/NZS 3008.1 for the following:

1. Maximum demand
2. Cable sizing and selection in accordance with proposed installation method
3. Cable tray and conduit sizing
4. Voltage drop calculations
5. Fault level calculations
6. Fault loop impedance

Utilise PowerCAD software to perform over current and short circuit protection calculations to validate each circuit breaker selection, trip unit and settings for the proposed electrical installation.

Provide time/current coordination curves for each selected circuit breaker to demonstrate the proposed electrical design has achieved the grading fault protection and discrimination for each protective device.

In addition, utilise the PowerCAD software to estimate the power factor correction and active harmonic filter sizing.

Maximum Demand

A maximum demand assessment must be undertaken in accordance with AS/NZS 3000 to include design input from:

1. TAFE NSW Design Standards
2. All trade services electrical loads
3. All existing equipment to re-connected
4. Liaison and consultation with user groups and stakeholders to include specialised equipment loads

4 Technical Sections

4.1 Electrical Supply

Mains Supply

Site Investigation

Undertake a site investigation to document site conditions, existing equipment to be re-connected, where spare capacity is required and to review the origin of electrical supply capacity available for the proposed project.

Point of Supply

Make a planning assessment to review the preferred point of supply from an existing switchboard to accommodate the proposed project electrical load requirements.

Where existing spare capacity is found to be insufficient an additional supply to the site is required. A supply network authority application must be prepared which addresses the following:

1. Proposed location for point of supply considering the impact of the site conditions
2. Indicate existing or proposed location of the main switchboard on a site plan
3. Indicate the service or consumer mains route and length of run
4. Maximum demand assessment details

The supply network authority should respond with a network connection offer, which may include an aerial supply connection, underground supply connection, or type of substation i.e. pole mounted, kiosk or surface chamber type.

If a substation is required, an accredited Level 3 service provider must be engaged.

Substation

In preparation for making an assessment to locate a proposed kiosk type or chamber substation the accredited level 3 service provider must take into consideration the following:

1. Truck access availability from a public road to allow installation and maintenance of the substation
2. Be on level ground
3. In close proximity to the main switchboard
4. Maintain smoke and fire zone clearance from the building structure
5. Clearance from tree canopies and tree protection zones
6. Clearance from gas meters or regulators
7. Clearance from fire hydrants or fire booster assemblies
8. Located above 1:100 year flood plane

4 Technical Sections

4.1 Electrical Supply

Alternative Power Supplies

Standby Generation

Standby generation is not typically required for TAFE NSW sites.

Where a building consists of an atrium and requires a standby generator in accordance with BCA/NCC or where a standby generator has been requested by project stakeholders then include within the project return services brief for approval by TAFE NSW.

Design of standby generators must be in accordance with NCC/BCA, AS/NZS 3000 and AS/NZS 3010.

Location of the diesel standby generator must take into consideration the following:

1. Height clearance of generator and exhaust flue
2. Maintenance access of generator enclosure
3. Area not sprinkler protected
4. Well ventilated area
5. Exhaust location is more than six (6) metres from any window opening
6. Proximity to main switchboard
7. Fire rating requirements in accordance with NCC/BCA
8. Noise attenuation to meet building occupant and boundary noise limits
9. Fuel storage location, point of fuel supply and fuel delivery truck access to site.

Mobile Generators

Where the site has been identified as a potential disaster recovery site then a mobile generator connection box and manual transfer switch located within the campus main switchboard must be included within the project return services brief for approval by TAFE NSW.

Location of the mobile connection box should take into consideration the following:

1. Temporary cabling to the main switchboard location
2. Area not sprinkler protected
3. Well ventilated area
4. Portable generator exhaust is more than six (6) metres from any window opening
5. Noise attenuation to meet building occupant and boundary noise limits
6. Delivery of portable generator truck access to site

Uninterruptable Power Supplies

Uninterruptable power supplies are not typically required for TAFE NSW sites.

Where UPS has been requested by project stakeholders to serve specific equipment then include within the project return services brief for approval by TAFE NSW.

4 Technical Sections

4.1 Electrical Supply

4.1.3 Deliverables

Design Submissions

Submit specifications and drawings which must indicate the following as a minimum:

1. Mains supply in liaison with ASP3
2. Alternative Supply:
   - Standby generator and associated fuel system
   - Mobile generator location
   - UPS system
3. Single line diagrams
4. Control schematics
5. Site plan indicating:
   - Location of the substation
   - Location of main switchboard
   - Site reticulation indicating conduit and pits of underground consumer mains route
   - Alternative standby generator and associated fuel storage location where required

Installer Submissions

Submit workshop drawings indicating location and dimensioned plan and elevation drawings of each item of equipment incorporating the following as minimum:

1. Switchboard ATS or MTS drawings
2. Controls and EMS, BMCS interface drawings
3. Meter panel arrangement
4. Standby generator enclosure layout and details with NCC/BCA, AS/NZS 3000, AS/NZS 3010
5. Standby generator electrical installation in accordance with AS/NZS 3000, AS/NZS 3010
6. Standby generator ventilation and acoustic provisions
7. Generator fuel storage and day tank details
8. Generator fuel system control schematic
9. UPS System and battery autonomy location and mounting details

Submit the following testing reports as a minimum:

1. Cable termination testing records
2. Phase balancing records
3. Control settings
4. Metering settings calibration records

4 Technical Sections

4.1 Electrical Supply

Manufacturer Workshop Submissions

Standby Generator System

Submit standby generator workshop drawings which must indicate the following as a minimum:

1. Design parameters
2. Construction details
3. Equipment technical schedules
4. Detailed dimensions of all engine/alternator/radiator/fuel storage/ exhaust system components and overall assembly
5. Plan and section views
6. Enclosure type and door access
7. BMCS and EMS Interface and control section and wiring details
8. Door details and opening arrangement
9. Ventilation requirements
10. Anti-vibration mounting seismic restraint details
11. Labels and warning signage

Submit the following standby generator manufacturer's technical data for all components as a minimum:

1. Makes, types and model numbers of generator, engine, fuel system and switchboard equipment
2. Type test certificates for, components, functional units and assemblies including internal arcing-fault tests and factory acceptance test data

Submit the following design calculations as a minimum:

1. Schedule for the proposed electrical installation
2. Time/current coordination curves for each selected circuit breaker indicating the resultant performance grading fault protection and discrimination for each protective device
3. Load stepping and generator supply compatible with UPS tolerances
4. Noise attenuation
5. Fuel system consumptions and storage capacity

Submit the following testing and commissioning reports as a minimum:

1. Factory Acceptance testing
2. Site Acceptance testing
3. Load testing with load bank
4. Integrated commissioning and testing with building electrical load

4 Technical Sections

4.2 Photovoltaic Systems

4.2.1 Summary

Photovoltaic systems must be provided as follows:

- Special Projects: Photovoltaic system to be sized to suit the capacity of the roof and as determined through a solar feasibility study. There is no maximum system capacity
- Major Works projects: photovoltaic system to be sized to suit the capacity of the roof to a maximum of 99kW
- Projects which include EV charging stations: in addition to the above, photovoltaic system to be sized to offset the load of any EV charging stations

Photovoltaic systems are not required for minor works projects or mini-minor works projects.

4.2.2 Design

The design consultant must review and develop the design of the photovoltaic system in accordance with the requirements of the following documents:

1. Greenstar energy monitoring or GHG reduction initiatives
2. ESD report outcomes
3. Network Distributor Standard
4. Service and Installation Rules of NSW
5. AS/NZS 3000
6. TAFE NSW energy monitoring initiatives or sustainability targets
7. NSW Infrastructure energy monitoring requirements
8. NSW Government Resource Efficiency Policy
9. NSW Government Net Zero Plan Stage 1 2020-2030
10. Project Brief

PV Capacity

The required photovoltaic capacity should be determined based on the scale of the project as noted below:

Special Projects

A photovoltaic system must be provided to all special projects. A full solar feasibility study must be undertaken to determine the capacity of the photovoltaic system and any supporting battery storage. The solar feasibility study must include:

- A review of the available roof space including orientation, overshadowing, requirements for other roof mounted services, access walkways for maintenance, access for viewing to support learning & teaching opportunities
- A cost/benefit analysis including review of payback period for the installation, estimation of any rebates or incentives and any maintenance costs
- Calculation of the electrical supply required for the building or project including a reasonable assessment of the hours that the building should be operational

There is no maximum capacity photovoltaic systems for special projects.

4 Technical Sections

4.2 Photovoltaic Systems

Major Works Projects

New buildings or new roofs: a photovoltaic system must be provided, as sized to suit the available roof area. The maximum capacity of the system is 99kW per incoming campus NMI bidirectional supply authority meter.

Refurbishment projects: solar panels should be provided, as sized to suit the available roof area. An assessment of suitability of the roof must be undertaken to determine whether the roof has the structural capacity to support the additional loads. Where the existing roof is not structurally adequate, solar panels are not required. The maximum capacity of the system is 99kW per incoming campus NMI bidirectional supply authority meter.

Projects which include EV charging stations

Any project which includes electrical vehicle charging stations must include a PV system sized to offset the capacity required for the EV charging station.

4.2.3 Components

Solar Panels

The photovoltaic panels must be selected for high energy efficient performance over a period of time, proven technology, longevity and minimum 20-year warranty.

Inverters

Each inverter module must be:

1. Located within a shaded external location or well-ventilated internal location in accordance with manufacturer recommendations
2. Maintain at least 500mm apart from each other and 500mm clear from walls, switchboards or other obstructions
3. Selected for their proven technology, longevity and minimum 7-year warranty

Battery

Battery connected PV systems should be provided where identified by any report or document listed above and are to be considered on a case-by-case basis.

A holistic, cost-effective design approach identifying procurement, installation and maintenance is to be prepared and included within the return services brief for TAFE NSW approval.

The battery modules must be selected for their high energy efficient performance over a period of time, proven technology, longevity and minimum 10-year warranty.

Review option for high level battery system status monitoring e.g. temperature, voltage status and the like and coordinate monitoring from BMCS.

4.2.4 Deliverables

Design Submissions

Submit specifications and drawings which must indicate the following as a minimum:

1. Solar feasibility study where required for the project scale
2. PV system
3. Single line diagrams
4. Control schematics
5. Roof photovoltaic cell layout drawings
6. Photovoltaic inverter and battery schematics

Installer Submissions

Submit workshop drawings indicating location and dimensioned plan and elevation drawings of each item of equipment incorporating the following as minimum:

1. PV circuitry and wiring
2. PV inverter locations and mounting details
3. PV battery locations and mounting details
4. Metering
5. Interface details to EMS and BMCS

Manufacturer Workshop Submissions

Submit photovoltaic, inverter and switchboard enclosure workshop drawings which must indicate the following as a minimum:

1. Design parameters
2. Construction details
3. Equipment technical schedules
4. Detailed dimensions of all modular components and overall assembly
5. Switchboard number of poles and spare capacity
6. BMCS and EMS Interface and control section and wiring details
7. Door details and opening arrangement
8. Address ventilation requirements
9. Mounting seismic restraint details
10. Labels and warning signage

Submit the following photovoltaic manufacturer's technical data for all components as a minimum:

1. Makes, types and model numbers of panels and inverter equipment
2. Type test certificates for, components, functional units and assemblies including internal arcing-fault tests and factory acceptance test data
3. Project specific certification of mounting and fixing methods

4 Technical Sections

4.2 Photovoltaic Systems

Submit the following design calculations as a minimum:

1. Schedule for the proposed electrical installation
2. Time/current coordination curves for each selected circuit breaker indicating the resultant performance grading fault protection and discrimination for each protective device

Submit the following testing and commissioning reports as a minimum:

1. Factory acceptance testing
2. Site acceptance testing
3. Integrated commissioning and testing

4 Technical Sections

4.3 Switchboards

4.3.1 Summary

The following switchboards are required to be provided:

1. New Campus Main Switchboards are required for new campuses or where works to an existing campus require an upgrade to the existing campus main switchboard. Campus main switchboards must be sized to suit the site load calculations + 30% spare capacity
2. New Building Distribution Boards are required for all new buildings or where works to an existing building require an upgrade to the existing building distribution board. Building distribution boards must be sized to suit the building load calculation + 20% spare capacity
3. New Distribution Boards are required for all new works or where works to an existing building require replacement of existing or additional new distribution boards. New distribution boards must be sized to suit the relevant load calculation + 20% spare capacity

All new switchboards must be located internally within a dedicated room or cupboard.

The switchboards should comprise of the following:

1. Switchgear, surge protection, metering of uniform manufacturer
2. A tier cubicle arrangement that is readily accessible
3. Allowance of spare cubicle space for future expansion
4. Control and BMCS sections to interface with other services

4.3.2 Design

Design Calculations

Utilise PowerCAD software to validate the design methodology to AS/NZS 3000 and AS/NZS 3008.1 for the following:

1. Maximum demand
2. Cable sizing and selection in accordance with proposed installation method
3. Fault level calculations
4. Fault loop impedance

Utilise PowerCAD software to perform over current and short circuit protection calculations to validate each circuit breaker selection, trip unit and settings for the proposed electrical installation.

Provide time/current coordination curves for each selected circuit breaker to demonstrate the proposed electrical design has achieved the grading fault protection and discrimination for each protective device.

In addition, utilise the PowerCAD software to estimate the power factor correction and active harmonic filter sizing.

4 Technical Sections

4.3 Switchboards

Campus Main Switchboard

The Campus Main Switchboard must:

1. Be located indoors within a dedicated room/cupboard
2. Provide fire rated construction where fire safety services are required in accordance with AS/NZS 3000 and NCC/BCA
3. Be of modular design to allow flexible expansion of the switchboard without modification to the busbar assembly
4. Be constructed with spare busbar capacity and busbars extensions with pre-drilled holes ready to serve future modular extension of the switchboard
5. Be constructed with a floor mounted galvanised steel plinth with minimum 75mm height AFFL
6. Incorporate steel glands
7. Have A3 size framed as-built single line diagrams within the room
8. Serve a number of building main distribution boards within the TAFE NSW campus
9. Be fed from a substation serving the TAFE NSW campus
10. Incorporate an underground trench located beneath the main switchboard of suitable size to accommodate underground cabling bending radii serving building main distribution boards

Technical Requirements:

1. Assembly: Manufactured in tier cubicle type arrangement configured for shipment and installation accommodated within the designated room and allowance made for future extension of an additional tier cubicle with future cabling access provisions
2. Access: Ensure access to busbars, terminations and the like for maintenance infra-red image testing
3. Fault Level: As directed by the supply Authority, e.g.: 30kA for 1 sec where served from a single 1000kVA substation
4. Form of segregation: Form 3b minimum
5. Ingress protection: IP42 minimum
6. Gland Plate: Glands sized to cable diameter
7. Label: the following labels must be provided:
   - Unique campus identification of main switchboard
   - Each section of switchboard
   - Origin of substation rating and number
   - All cubicles with designated load description, protective device rating, trip setting and cable size, otherwise designated spare
   - Each interface and controls compartment

Cubicle sections must be arranged within the following sections:

1. Incoming supply authority section, consisting of the following:
   - Incoming Section Busbar Rating: to match incoming maximum demand rating +minimum 30% spare capacity subject to master planning requirements
   - Service protection device
   - Supply authority metering chamber
   - Surge protection facility
   - Optional: manual transfer switch or automatic transfer switch

2. Safety services section, in accordance with AS/NZS 3000 consisting of the following:
   - Safety service busbar section: to match safety service demand rating + minimum 10% spare capacity
   - Fire service equipment
   - Hydrant service equipment
   - Mechanical life safety equipment
   - Spare: 1x200A supply
   - Private metering for each outgoing circuit
3. Metered section, consisting of the following:
   - Metered busbar section: to match demand rating +minimum 20% spare capacity
   - Each building main DB supply
   - Lift services equipment
   - Local main switch serving:
     - Electrical services equipment
     - Specialist equipment
     - Mechanical equipment
     - Power factor or active harmonic filter
   - Spare: subject to master planning of additional buildings, minimum 2x400A/phase
   - Private metering for each outgoing circuit
4. Unmetered section, consisting of the following:
   - Unmetered busbar section: to match prospective tenancy demand rating + minimum 10% spare capacity
   - Any tenancies
   - Spare: Minimum 1x200A/phase
   - Private metering for each outgoing circuit
5. Interface section:
   - Private metering interface connection
   - BMCS interface connection
   - EMS Interface connection

Building Main Distribution Board

The building main distribution board must:

1. Be located indoors within a dedicated room/cupboard
2. Provide fire rated construction where fire safety services are required
3. Have A3 size framed as-built single line diagrams within the room
4. Incorporate steel glands
5. Serve a number of distribution boards within the building and neighbouring external areas
6. Be fed from the campus main switchboard

4 Technical Sections

4.3 Switchboards

Technical Requirements:

1. Assembly: Manufactured in tier cubicle type arrangement configured for shipment and installation accommodated within the designated room.
2. Access: Ensure access available to busbars, terminations and the like for maintenance infra-red image testing
3. Fault Level: Calculated from campus main switchboard fault rating
4. Form of segregation: Form 3bih minimum
5. Ingress protection: IP42 minimum
6. Gland Plate: Glands sized to cable diameter
7. Label: the following labels must be provided:
   - Unique campus identification of main distribution board
   - Origin of campus main switchboard circuit number
   - Each section of switchboard
   - All cubicles with designated load description, protective device rating, trip setting and cable size, otherwise designated spare
   - Each interface and controls compartment

Cubicle sections must be arranged within the following sections:

1. Incoming supply authority section, consisting of the following:
   - Main switch
   - Surge protection facility
   - Optional: Manual transfer switch or automatic transfer switch
   - Incoming Section Busbar Rating: to cater for service protection device rating
2. Safety Services Section, in accordance with AS/NZS 3000 consisting of the following:
   - Safety Service Busbar section: to match safety service demand rating + minimum 10% spare capacity
   - Fire service equipment
   - Hydrant service equipment
   - Mechanical life safety equipment
   - Spare: Minimum 1x200A supply
   - Private metering for each outgoing circuit
3. Metered Section, consisting of the following:
   - Metered Busbar section: to match demand rating +minimum 20% spare capacity
   - Electrical services equipment
   - Specialist equipment
   - Mechanical equipment
   - Lift services equipment
   - Power factor or active harmonic filter
   - Spare: Minimum 2x200A/phase
   - Private metering for each outgoing circuit
4. Interface Section:
   - Private metering interface connection
   - BMCS interface connection
   - EMS interface connection

4 Technical Sections

4.3 Switchboards

Distribution Board

The distribution board must:

1. Be located such that the switchboard is accessible from an indoor corridor space within a dedicated electrical non-combustible and smoke sealed cupboard; or located within a plantroom where dedicated maintenance spaces and egress requirements are met
2. Incorporate lockable removable doors and removable hinged escutcheon
3. Have as-built type written distribution board schedules provided for each chassis section
4. Provide control and interface section A3 drawings placed within distribution board holders
5. Be fed from the building main distribution board
6. Be fitted with DIN rails for mounting of controls in dedicated sections
7. Be fitted with single pole RCBO's of minimum 16A rating for lighting circuits and 20A rating for power circuits
8. Incorporate a main switch rated at 160A minimum

Technical Requirements:

1. Assembly: Configured for installation to be accommodated within cupboard space
2. Access: Ensure access available to busbars, terminations and the like
3. Doors: Maintain clearances from cupboard doors
4. Fault Level: Calculated from campus main switchboard or main distribution board fault rating
5. Form of segregation: Form 1 minimum
6. Ingress protection: IP42 minimum
7. Gland plate: Where multiple cables are passing through a gland, sealants are to be applied to maintain IP integrity
8. Main Switch: Segregated and/or shrouded from remaining distribution board
9. Label: the following labels must be provided:
    - Unique campus identification of distribution board
    - Origin of main switchboard/main distribution board circuit number
    - Each section of switchboard
    - All circuits with protective device rating with emergency lighting warning to AS/NZS 2293
    - All security and critical communication circuits "Do NOT turn off" warning
    - Each interface and controls compartment
    - Emergency testing switch instructions

Cubicle sections must be arranged within the following sections:

1. Incoming supply authority section comprising of the following:
    - Main switch
    - Surge protection facility
    - Private meter
    - 250A busbar rating

2. Lighting Section comprising of the following:
   - Private meter CT to lighting chassis
   - 100A busbar rating
   - Lighting chassis
   - Spare poles: 10% spare capacity
3. Power Section comprising of the following:
   - Private meter CT to power chassis
   - EPO control chassis
   - Mechanical air-conditioning split system chassis
   - Specialty equipment that requires 40A or greater must be served from line side of main switch with private meter
   - Spare poles: 20% spare capacity
4. Interface and controls sections including the following:
   - Private metering interface connection
   - BMCS interface connection
   - EMS interface connection
   - Emergency lighting test facility and controls
   - Lighting control section
   - EPO control section

Location of Switchboards

All new switchboards or switchboards upgraded as part of building refurbishment works must be located internally:

1. Within a dedicated electrical switchroom or cupboard
2. In a readily accessible location from a circulation space or corridor and not through work areas, classrooms or similar
3. Located strategically to reduce cable runs and to stack vertically in multi-storey buildings

Dedicated communications rooms or cupboards are not acceptable locations for general switchboards.

Externally located switchboards should only be considered for maintenance or replacement of existing switchboards due to their increased capital and maintenance cost.

4 Technical Sections

4.3 Switchboards

Switchboard rooms and cupboards

Switchboard rooms and cupboards must:

1. Be designed to suit the clear dimensions of each switchboard including spare capacity and minimum 2.1m high. Allow space on either side of the switchboard for servicing
2. Be configured such that the arrangement complies with the wall and door construction, egress requirements, maintenance clearance requirements and door openings, in accordance with NCC/BCA and AS/NZS 3000
3. Have outward opening doors, and for cupboard the doors must be the full width of the cupboard. Doors must be designed to not obstruct passageways when in the open position
4. For campus main switchboards, provide external access for meter reading and the like
5. Be located above 1:100 year flood plain
6. Be mechanically ventilated to reject dissipated heat as required
7. Have secure key lockable door access to TAFE NSW keying arrangement

Switchboard rooms and cupboards must not:

1. Expose switchboards to damp walls. Ensure when located below ground, all walls are double skin or are provided with a suitable waterproof sealed membrane in order to remain dry at all times
2. Have construction joints within slabs
3. Contain any mechanical, fire or hydraulic pipework services within the room
4. Position the switchboard under an air-conditioning unit.

4.3.3 Components

Switchgear and Control gear

All switchgear must be selected to provide discrimination between upstream and downstream devices.

In general, discrimination must be arranged so that in the event of a fault, only that switchgear immediately upstream of the fault should operate to clear the fault. For the purposes of this clause, devices include circuit breakers or fuses.

Where existing switchgear is being reused or remains in place at completion of the works, discrimination must be achieved between new and existing devices and details of protection settings submitted must include existing devices.

Allow to modify settings of protective devices on existing equipment within their capability to improve discrimination if necessary.

All switchgear and circuit breaker protection equipment must be:

1. A consistent manufacturer/brand throughout the building installation and for the area under modification
2. Fully coordinated and selected where possible to fully discriminate and cascade and offer fault current limiting features in the range
3. Compatible with existing switchboard busbar arrangement

4. Installed to match the existing manufacturer/brand when practically available

Residual Current Devices

Residual Current Device (RCD) protection should be provided on all nominated sub-circuits, as per the requirements of AS/NZS 3000. Generally, all RCDs should be provided with integral overcorrect protection.

All RCDs should be of the same manufacturer as the remaining switchgear throughout the installation.

Surge Protection

Surge protection must be incorporated as follows:

1. Incoming supply section of main switchboard
2. Incoming supply to distribution board dedicated to serve audio-visual, communication, security equipment and the like
3. Each individual outgoing circuit serving audio-visual, communication, security equipment and the like where served from a common chassis

Authority Tariff Metering

Supply authority bulk tariff metering must be installed within the main switchboard in accordance with:

1. Energy retailer metering requirements
2. Network standards
3. NSW service and installation rules

In the case where directly connected to a substation serving a TAFE NSW main switchboard, authority tariff metering current transformers must be incorporated within the switchboard enclosure.

An authority tariff meter should only be provided to tenancies which are either entire buildings or multiple levels within a building, where served from the unmetered section of the main switchboard. Authority tariff metering is not required to minor tenancies consisting of rooms or spaces within a building. Tenancy leasing agreements are to include for the electrical ongoing costs for a non-metered supply to serve minor tenancies.

Provide a bi-directional supply authority multi-function energy smart meter with ‘Time of Use’ capabilities for photovoltaic metering systems.

Private Metering (Multi-Function Energy Smart Meter)

Private multi-function energy smart meters and CTs of tariff accuracy classification and class 0.5M must be incorporated within:

1. Incoming section: campus main switchboard
2. Incoming section: each building distribution board
3. Sub-tenant supply

These meters must:

1. Be configured to allocate energy usage charges
2. Record all kVA, kWh, Pf, V, A, maximum demand and power harmonics quality data
3. Have Modbus or BacNet native protocols available

4 Technical Sections

4.3 Switchboards

Private Metering (Energy Consumption)

Energy sub-metering must be installed to monitor energy consumption loads for:

1. Compliance with NCC/BCA section 8.3 requirements
2. Any additional loads as required to satisfy any energy rating scheme for the project
3. Any specialty equipment greater than 50A/phase

These meters must have Modbus or BacNet native protocols available.

Power Factor Correction

An appropriately sized Power Factor Correction (PFC) unit must be installed adjacent to the campus main switchboard within the development.

PFC units must be selected and sized to achieve an average site power factor between 0.95 and unity.

The power factor correction unit must be sized upon measurement of TAFE NSW campus loads when buildings are occupied in the order of 80% utilising energy metering system capacity.

The power factor correction equipment must be manufactured as a dedicated island floor mounted modular cubicle, with at least two cooling fans per cubicle, in accordance with the switchboard section above. The equipment must match the colour of the campus main switchboard.

The campus power factor unit must incorporate a capacitor installation compliant with AS/NZS 1013 and IEC 831-1 of at least four steps with a minimum of 25kVAR steps with the remainder to be a maximum of 50kVAR steps subject to overall sizing.

The power factor controller must comprise of the following:

1. Microprocessor controlled
2. Automatic cyclic switching of capacitor banks to ensure even duty on all components
3. Unoccupied stages cannot be switched on or off
4. Display as a minimum the number of stages switched on, the actual power factor, apparent and reactive power, current etc.
5. Serial port (RS485) Modbus protocol interface or Bacnet interface
6. Harmonic voltage and current distortion
7. Digital display
8. Alarm condition and over-temperature relays

The power factor unit must be reliable with longevity design life for 20 years minimum.

4 Technical Sections

4.3 Switchboards

4.3.4 Construction

Internal Switchboards

All internal switchboards must be constructed:

1. To be compliant with AS/NZS 3000, AS/NZS 61439.1 and AS/NZS 61439.2 and supply authority requirements
2. To allow uniform accessible layout of modular functional protective device and cable access compartments in a tier arrangement allowing for spare poles and/or expansion of additional tier cubicles
3. To incorporate busbar capacity and arrangement allowing for spare capacity for future electrical growth
4. To incorporate metering, BMCS interface and control cubicles to satisfy TAFE NSW requirements
5. To comply with quality manufacture and installation of switchboard to WH&S, statutory authority and regulation requirements
6. To IP42 unless a sprinkler is located within the room or cupboard, then IP56
7. To allow readily accessible easy access for operation and maintenance clearance in accordance with AS/NZS 3000
8. To allow easy shipment in modular sections as required for installation and access within designated space
9. With steel metalwork to achieve a rigid assembly, modular extruded framework, reinforced and stiffened panels and sheeting free from deflections, distortion, or misalignment
10. To allow configuration of switchboard assembly to accommodate busbars, protective devices, functional units, metering equipment, incoming and outgoing cabling reticulation and terminations, interface and control termination equipment and the like
11. To allow access for maintenance and any future extension and modification without the removal of equipment
12. To achieve the form, design, compartmentation and segregation requirements to busbars, functional units, protective devices, cabling and terminations
13. With colour coded active neutral and earth insulated busbars sized to deliver the current carrying capacity for active conductors so that the final temperature must not exceed 900C and full-sized neutral busbar conductor must be provided
14. With spare cable reticulation and busbar capacity extended to serve all spare poles
15. To permit access for thermographic maintenance testing
16. With doors sized no greater than 800mm, with resilient neoprene dust seals around perimeter of door openings. All door mounted equipment terminals must be shrouded, and doors provided with an earth cable to maintain continuity
17. To incorporate escutcheons of maximum 1200mm height, matching door width, to all mains voltage sections of the switchboard to prevent any potential exposure to live parts whilst door is open and be provided with fixings and handles to readily and safely be able to remove and re-assemble and fix in position the escutcheon without a tool
18. With labels for warning and danger notices
19. With an aluminium removable gland plate to accommodate all incoming and outgoing cabling glands and gaskets selected to maintain the designated IP rating

20. With two pack powder coated finish:
    - Internal assembly: white gloss finish
    - External assembly: orange X15 satin texture finish, including doors and escutcheon
21. With seismic restraints to AS/NZS 1170.4 section 8
22. To incorporate all labelling of equipment and all consumer mains and submain origin, destination and cable sizes

External Switchboards

Where an external switchboard has been accepted by TAFE NSW then the following additional construction requirements are to be incorporated:

1. Anti-corrosive treatment to AS/NZS 61439
2. 3mm thick steel or aluminium construction
3. Anti-corrosive protective paint coating
4. Busbar size increased to allow for de-rated capacity allowing for an ambient of 60^{0}C to AS/NZS 61439
5. IP56 construction
6. Sloping roof detail away from switchboard door opening
7. Guttering around roof detail and weatherproof seals provided to door surrounds
8. Stainless steel door hardware, hinges and fixings
9. Anti-condensation heater
10. Weatherproof IP56 box louvres with insect proof mesh

4.3.5 Deliverables

Design Submissions

Submit switchboard specification and drawings which must indicate the following as a minimum:

1. Switchboard specification including construction and functional requirements
2. Main switchboard, main distribution board and distribution board single line diagrams
3. Switchroom and cupboard location, elevation and layout drawings
4. Metering methodology and metering installation schematics
5. Power factor and active harmonic filter schematics

Installer Submissions

Submit switchroom and cupboard workshop drawings indicating location and dimensioned plan and elevation drawings of each wall incorporating the following as minimum:

1. All switchboards including coordination of other services switchboards and indicating switchboard door swing maintenance clearances and egress in accordance with AS/NZS 3000
2. Meter panel arrangement
3. Inverters
4. Active harmonic filters or power factor correction equipment

4 Technical Sections

4.3 Switchboards

Submit the following testing reports as a minimum:

1. Cable termination testing records
2. Phase balancing records
3. Metering settings calibration records

Manufacturer Workshop Submissions

Submit switchboard workshop drawings which must indicate the following as a minimum:

1. Design parameters
2. Construction details
3. Equipment technical schedules
4. Busbar arrangement assembly details
5. Detailed dimensions of all modular components and overall assembly
6. Elevation and general plan views indicating compartmentation and segregation of switchgear with busbars
7. Switchboard section, chassis arrangement indicating number of poles and spare capacity
8. Details of gland plates and cable management routes within assemblies
9. Interface and control section and wiring details
10. Door details and opening arrangement
11. Plinth details and ventilation openings
12. Mounting seismic restraint details
13. Labels and warning labels

Submit the following switchboard manufacturer's technical data for all components as a minimum:

1. Makes, types and model numbers of items of equipment
2. Type test certificates for components, functional units and assemblies including internal arcing-fault tests and factory acceptance test data
3. Submit the following design calculations as a minimum:
    - PowerCAD over current and short circuit protection calculations and indicate each circuit breaker selection, trip unit and settings within equipment schedule for the proposed electrical installation
    - Time/current coordination curves for each selected circuit breaker indicating the resultant performance grading fault protection and discrimination for each protective device

Submit the following testing and commissioning reports as a minimum:

1. Factory acceptance testing
2. Site acceptance testing
3. Integrated commissioning and testing

4 Technical Sections

4.4 Energy Management Systems

4.4.1 Summary

An energy management system must be provided to all works including:

1. New building works
2. Major works projects including refurbishment of existing buildings

An energy management system must incorporate a campus based energy monitoring and reporting system. The system must be accessible, user friendly and integrate display screens for staff, student and public viewing.

The energy management system must:

1. Incorporate a user-friendly platform to integrate custom project specific energy monitoring and reporting requirements
2. Allow software to be installed on a server/network with security access
3. Be fully compatible to monitor and collate all data from:
   - NMI certified meters
   - Private multi-function energy smart meter
   - Private consumption energy smart meter
   - Electric vehicle charging monitoring
   - Solar PV system including battery storage
   - Wind turbine generation
   - Gas and water meters
4. High level Bacnet interface to the BMCS
5. Digital signage/digital messaging interface
6. Incorporate an icon based graphic user interface (GUI)

4.4.2 Design

The design consultant must review and develop the design of the energy management system to incorporate the requirements outlined within the following documents:

1. Compliance with NCC/BCA Section J8.3
2. Greenstar energy monitoring initiatives to be undertaken
3. ESD report outcomes
4. TAFE NSW energy monitoring initiatives
5. NSW Infrastructure energy monitoring requirements

User Group Access

The energy management system must:

1. Be made available to TAFE NSW staff for secure local or remote access, live monitoring, and management of data. Tailored reporting must be available for any TAFE NSW departments, including but not limited to:
   - Facilities management
   - Building management
   - Sustainability
2. Display live monitoring to TAFE NSW teaching staff via local secure access available to network for each site
3. Utilise digital signage display screens for live energy monitoring to TAFE NSW students and the public to facility requirements

4 Technical Sections

4.4 Energy Management Systems

Functional Requirements

The following energy management functions must be available for each user to enable tailored output display and reporting:

1. Real-time monitoring of all base building energy meters for MSSBs, plant (including all associated common area mechanical systems, hydraulic services, basement common services such as ventilation, lifts, lighting, power distribution boards usage)
2. View energy usage for each common area, and common area plant/ equipment
3. Real time building performance data to be available in graphical format for display in common areas for occupant information (digital signage function)
4. Ability for the building manager to export raw data for research/ information purposes by third parties
5. Ability to identify irregularities in energy usage to assist with energy management, fault finding etc.
6. Ability to intuitively 'load forecast' based on historical energy usage
7. Ability to input per kW costs to manage usage and budget
8. Ability to display graphical mediums such as CO_2 emissions saved
9. Alarm and event management to be interfaced with interface compatible third-party systems such as BMCS, PV, EV charging and the like systems
10. Dashboards displaying:
    - Energy performance and monitoring
    - Power availability, quality and reliability
    - Power factor and harmonic load monitoring
    - Sustainability performance
    - Load forecast
    - Weather forecast
    - Energy prices
    - Occupancy and demand
    - PV solar array performance and battery charging
    - EV charging bay status
    - Site energy usage comparison relevant to time of day/peak period usage.
    - General site energy usage statistics as per any Greenstar requirements

The above operational functional requirements are to be further developed with TAFE NSW and the ESD consultant during the design development phase.

Integration

Each TAFE NSW campus must be able to configure digital signage to display the following statistics:

1. Previous day site wide common area power usage
2. Previous week site wide common area power usage
3. Average site wide common area power usage
4. Previous month site wide common area power usage

4 Technical Sections

4.4 Energy Management Systems

Platform Structure

The energy management system software (EMSS) must:

1. Operate on one platform
2. Allow real time monitoring
3. Allow at each location a graphical monitoring and analysis application which provides energy analysis via reports and dashboards. Provide tools for energy analysis, power quality analysis, power system monitoring and control
4. Employ a graphical monitoring and analysis application to enable a user to create a comprehensive set of linked hierarchical diagrams showing all devices and their associated device specific diagrams in the power monitoring network with a single mouse click (auto-diagram creation)
5. Employ a graphical monitoring and reporting application to support custom graphics/images and provide the ability to create diagrams of the power monitoring system, including electrical single-line diagrams of the site MSBs. Single-line diagrams to allow access to individual meter data, facility maps, plan views, floor layouts, equipment representations, and mimic displays
6. Employ power monitoring trending including charts for real-time trending of power usage (kW, volt, amp, and kWh) or any measurement supported by metered equipment such as generators and MV/LV switchgear
7. Display real-time data and/or historical data per data series, with optional back-filling of the real-time data using historical data
8. Export trend data to .csv/excel format
9. Access trend data from a web browser or mobile environment
10. Provide a load simple monitoring management feature for the evlink structure to enable maximum site charge demand to be limited to a set demand and to provide energy monitoring to determine real time energy usage
11. Incorporate the ability to interrogate and view the status and output of the inverter system. The system should connect via the EMS network to view energy produced, logging of historical data and for fault/ maintenance purposes

4 Technical Sections

4.4 Energy Management Systems

4.4.3 Deliverables

Designer Submissions

The designer should provide the following submissions:

1. Design specifications indicating scope, operational and functional requirements
2. Single line diagrams indicating location of meters
3. Photovoltaic system schematics
4. Electric vehicle charger interface
5. Gas and water meter interface
6. High level interface points list

Integrator Submissions

The integrator should provide the following submissions:

1. Present on-screen the proposed graphical user interface of all facets of the proposed EMS and carry out a demonstration of the user experience
2. Provide a logic chart which depicts the structure of the EMS
3. Integration code required to third party systems
4. Configuring matrix to address each meter
5. Configuration of dashboard and digital signage displays
6. Workshop drawing indicating a logic chart which depicts the structure of the EMS together with screen captures of the GUI showing the user experience
7. Comprehensive EMS schematic of the entire network indicating works to be executed and works by others

4 Technical Sections

4.5 Accessories

4.5.1 Summary

Electrical accessories must be provided in accordance with this Design Standard for all projects including:

1. New building works
2. Renovations or refurbishment of existing buildings where new accessories are provided
3. Any furniture or equipment replacement programs where new accessories are provided

Each area must be served with the number of outlets to suit the requirements of equipment, staff and students.

The outlet rating and type must be selected to suit the application and environmental conditions.

The location and mounting height must be accessible to suit the requirements of the space.

The outlet and equipment mounting method must be in accordance with the functional, operational and maintenance requirements of each room, area or building.

Liaise and consult with TAFE NSW, with particular regard for regional areas, on the availability of local suppliers to provide accessories including spares as specified.

4.5.2 Design

The design and configuration of all accessories must:

1. Be installed in accordance with the requirements of AS 1428.1 and AS 1428.2
2. Accommodate the environmental conditions including dust, moisture and resistance requirements for the area served

Typical Mounting Heights

All accessories must be mounted at the following heights, except where mounted on workstations, joinery, skirting ducts etc or where required to be mounted at a different height by Australian Standards or the NCC.

Application	Mounting Height
Above bench	150mm above the surface of the bench to the centre of the outlet faceplate
Below bench	150mm below the surface of the bench to the centre of the outlet faceplate
Wall mounted	Between 900 and 1100mm above floor level to the bottom edge of the outlet faceplate
Cleaner's outlets	200mm above floor level to the bottom edge of the outlet faceplate
Hazardous areas	>300mm above floor level to the bottom edge of the outlet faceplate

4 Technical Sections

4.5 Accessories

4.5.3 Components

Accessory Finishes

The finish of all accessories (white, black, stainless steel etc) must be coordinated with the architect and/or the TAFE NSW project lead during the detailed design phases.

In heritage buildings, the type and finish of all accessories must match existing, unless otherwise approved.

Where critical services are served by standby generator then allow for red outlets and/or where served from UPS system allow for blue outlets.

Accessory Types

The designer must incorporate the following accessory types to suit the application and scale of the project. Refer to *Table 2 – Schedule of Accessory Requirements* to establish the requirements for each type of space.

Socket Outlets

All socket outlets provided in student areas must be double 10A socket outlets with twin fast charging USB outlets. Generally, twin USB outlets must consist of one (1) Type-A USB outlet and one (1) Type-C USB outlet.

Single socket outlets should only be used for cleaner's outlets or to supply fixed equipment. In this instance, USB outlets are not required.

All outlets selected must have a non-removable portion of the faceplate to accommodate the required socket outlet labelling.

In surface mounted applications, horizontal/vertical mounting blocks must be used and mounted to the structure as per manufacturer recommendations. All mounting screws must be fully isolated from electrical cabling. The cable entry cut-outs into the mounting block must be appropriately sealed to prevent access to electrical cabling.

External Socket Outlets

All socket outlets installed external to a building or in damp situations should have a minimum ingress protection rating of IP56. All external socket outlets should be installed in a position that does not obstruct the path of travel or introduce a trip hazard, i.e. wall mounted or adjacent to garden beds.

USB Outlets

Generally, all socket outlets, power rail, table boxes or above bench solutions must be provided with integrated USB outlets.

Generally, twin USB outlets must consist of one (1) Type-A USB outlet and one (1) Type-C USB outlet.

4 Technical Sections

4.5 Accessories

Starter Sockets

Starter sockets must be rated to a minimum of 20A and be connected to a dedicated circuit. All starter sockets must be mounted in position on a permanent section of the building so that they are not disturbed by the removal of the equipment supplied by the starter socket. Starter sockets must not be mounted to removable workstations or joinery.

Power Rails

General power to all workstations must be supplied via soft-wired modular power rails mounted above or below bench. All workstation outlets must be coordinated with the architect and/or TAFE NSW project lead and procured as part of the workstation package, with the starter socket provided in the electrical scope of works.

The quantity of power outlets for general areas must align with the minimum allocations nominated in Section 4.5.5 Schedules. The quantity of power outlets for any specialist areas not listed as otherwise advised by TAFE NSW.

Coordinate with architectural furniture and joinery drawings for the typical power rail configurations for workstations.

Floor Boxes

Floor boxes should not be used for reticulating power in areas without nearby partitions due to WH&S risks. Floor boxes must only be used at TAFE NSW's discretion and are to be included in project return services brief for TAFE NSW approval.

Utilise low profile, clearly visible floor boxes. Floor boxes should be of stainless-steel construction. Floor box covers must be stainless steel or brass with a recess for floor finish insert. Plastic composite floor box covers must not be used. The configuration and quantity of outlets installed within a floor box should be coordinated with TAFE NSW.

Floor boxes must be sized to allow appliance adaptors to be concealed within the floor box when in use.

Where the installation of a floor box requires penetrations or chasing of structural slabs, a fire rating method must be employed to maintain the fire rating integrity of slab. Approval from the structural engineer must be provided prior to construction.

Refer to manufacturer's literature and recommendations for the installation of floor boxes and outlet configuration details.

Typical applications for use of floor boxes accepted by TAFE NSW are as follows:

1. Reticulation of cabling from the floor to table boxes for fixed/semi fixed tables not adjacent walls, i.e. meeting rooms
2. In large rooms where power is required in the centre of the rooms, i.e. large group learning rooms.

4 Technical Sections

4.5 Accessories

Table Boxes

Table boxes must only be used for fixed joinery. Table boxes must be provided and installed by the joinery manufacturer. All table boxes must be provided with brushed lids.

All power outlets within table boxes must be soft-wired, with the configuration of outlets coordinated with the TAFE NSW project lead.

Table boxes should be sized to allow appliance adaptors to be concealed within the table box when in use.

Refer to the manufacturer's literature and recommendations for the installation of table boxes and outlet configuration details.

Service Poles/Pendant Power Outlets

Ceiling mounted services poles and pendant power outlets should be used in laboratory and workshop applications where joinery or wall mounted outlets are not suitable. The use of service poles and pendant power outlets may be suitable in other applications, include within project return services brief for TAFE NSW approval. All pendant outlets should be retractable.

Bench mounted service poles may be used in laboratory or workstation applications with fixed island benches.

All service poles containing power and communication cabling must have segregated compartments for the reticulation of power and communication cabling, as per the requirements of AS/NZS 3000 and AS/CA S009.

All service poles must use faceplates where the pole meets the ceiling or bench top to provide a neat transition. The finish of service poles should be coordinated with the architect and/or TAFE NSW project lead.

The consultant/contractor must confirm the requirements for service poles and pendant power outlets with TAFE NSW during the concept design phase.

Power Boards and Extension Leads

TAFE NSW discourages the use of power boards and extension leads due to significant WH&S risks (i.e. trip hazards). Consultants/contractors should coordinate the outlined power outlet allocations with TAFE NSW to limit the need for power boards and extension cords by the end users.

Communication and Computer Equipment Rack Outlets

Provide 15A pendant captive outlets serving integrated rack power rails which must:

1. Provide a matching plug top with a captive screw ring for each outlet
2. Not be served from RCBO to avoid nuisance tripping
3. Labelled in accordance with AS/NZS 3000, with label clearly visible without climbing
4. Incorporate 15A rated outlets with illumination power LED indicator
5. Incorporate pin arrangement selected to suit the rack power rail
6. Be IP56 type construction type of impact-resistant plastic, with spring loaded flap lid on the socket and captive socket thread
7. Be suspended at a readily accessible mounting height and location overhead coordinated with communication cabinet layout

4 Technical Sections

4.5 Accessories

Emergency Power Off (EPO)

Emergency Power Off (EPO) must be:

1. Provided within any laboratory or mechanical machine workshop
2. Provided when required by specialised equipment
3. Accessible to staff
4. Located as required by standards or regulatory codes
5. Coordinated and located adjacent to local gas shutdown
6. Reviewed by the project Crown Certifier
7. Provided with shroud to prevent any incidental operation
8. Provided with local re-instating and disengaging facility
9. Provided with a clear label with operating instruction
10. Separated by 500mm from other room controls
11. Control of motorized circuit breaker serving EPO chassis section of distribution board

Accessory Labelling

All power outlets must be provided with an engraved traffolyte label fixed with double sided adhesive tape to the non-removable portion of the faceplate. Where there is no non-removable portion of the faceplate, an engraved traffolyte label should be attached to the removable portion of the faceplate. In this instance, the fixed portion of the outlet should be labelled with permanent marker in an area concealed by the faceplate.

The engraved traffolyte labels must consist of black lettering engraved into a white background with a 5 mm letter height in a single line.

All labelling must clearly indicate the location of the upstream protective device, including the designation of the upstream distribution board and sub-circuit number.

DB-1 – L08

Where:

DB-1 the distribution board designation, eg Level 1

L28 is the sub-circuit termination number eg L-lighting cassis termination number:08

The labelling must clearly indicate the origin of the circuit with distribution switchboard and circuit breaker designations.

4.5.4 Deliverables

Design Deliverables

The electrical designer must consult with the design team to select suitable outlets for the area or space which meet the design objectives and requirements.

Each accessory type selected must be presented within schedule or cut sheet format indicating the following:

1. Outlet type colour photo image
2. Switch configuration/LED indication

3. Finish type
4. Current rating
5. Ingress protection rating
6. Mounting on workstation, table top, wall or ceiling or floorbox- recessed, semi-recessed, surface, suspended and mounting height
7. Selected outlet make and model number
8. Room or area served

New Build and Major Refurbishments

The following documents are to be developed for submission to TAFE NSW as follows:

Concept Submission: A qualitative description of outlets with labelling intended for each area in collaboration with the design team must be prepared and submitted within the return services brief documents submitted to TAFE NSW for review and comment.

Design Development: Upon receipt of the developed furniture plans, the electrical consultant must collaborate with the design team to develop the electrical accessory design and layout. Select outlet types which should satisfy the aims and objectives of the project and any mandatory or statutory requirements. Liaise and consult with the TAFE NSW project lead on procurement of replacement outlets where required. A preliminary completed outlet schedule or individual outlet cut sheets must be prepared by the electrical consultant and submitted for review at the design development stage.

Tender Submission: Upon finalisation of the furniture plans, the electrical designer must produce fully coordinated power outlet layouts for review and acceptance by the design team prior to completing layout drawings. Indicate circuitry information and a schedule of outlets for submission to TAFE NSW at least four weeks prior to tender, or as otherwise noted in the project program, for TAFE NSW acceptance.

Installer Deliverables

Construction Phase: implement any value management initiatives identified during the tender stage if accepted by TAFE NSW. The electrical installing designer must revise and resubmit all drawings, schedule and documents and submit workshop drawings for review and acceptance.

1. Submission of samples must include:
   - Specified outlet samples along with any alternatives proposed for comparison
   - Technical outlet type specifications and performance data
2. Submission of workshop drawings must include:
   - Final power outlet coordinated power layouts at scale 1:100
   - All technical data sheets.

4 Technical Sections
4.5 Accessories

4.5.5 Schedules

The following tables defines the minimum number of power outlets that must be provided for specific spaces. This table identifies the minimum number of outlets for general spaces only. The final quantity and type of outlets for specialist spaces should be project specific and coordinated with TAFE NSW requirements.

General Learning Spaces

Lecture Theatres

Space	Standard Allocation
General	Provide one (1) double 10A socket outlet with integrated twin USB outlets for every third seat within the seating area
Lectern	Each lectern should be provided with one (1) double socket outlet with two (2) USB outlets mounted above bench

General Classrooms

Space	Standard Allocation
Small Group Learning Rooms (8 occupants)	Provide four (4) double 10A socket outlets with integrated twin USB outlets.
Medium Group Learning Rooms (16 people)	Provide eight (8) double 10A socket outlets with integrated twin USB outlets.
Large Group Learning Rooms (24-30 people)	Provide one (1) socket outlet with integrated USB outlet per person to accommodate 50% of the maximum number of occupants, rounded up to the nearest double 10A socket outlet with twin USB outlets.

Informal Learning Areas

Space	Standard Allocation
Informal Learning Area	Generally, provide one (1) double 10A socket outlet with combined twin USB outlets for every 5m^2 of informal learning area (excluding the areas listed below).
Informal Learning Area-Cafe	Provide one (1) above bench socket outlet combined with USB outlet per person to accommodate 50% of the maximum number of occupants.
Informal Learning Area-Study Benches	Provide one (1) socket outlet with combined USB outlet per occupant.
Informal Learning Area-Outdoor Learning Spaces	Provide one (1) IP56 socket outlet to accommodate 30% of the maximum seated occupants.

4 Technical Sections

4.5 Accessories

Collaboration, Study & Breakout Spaces

Space	Standard Allocation
Maker Space	Provide one (1) socket outlet with integrated USB outlet per person to accommodate 50% of the maximum number of occupants, rounded up to the nearest double 10A socket outlet with twin USB outlets.
Media Lounge	Provide one (1) double 10A socket outlet with integrated twin USB outlets per person to accommodate 25% of the maximum number of occupants (i.e. one (1) 10A socket outlet per every two occupants). A minimum one (1) double 10A socket outlet with integrated twin USB outlets must be provided.
Social Lounge	Provide one (1) double 10A socket outlet with integrated twin USB outlets per person to accommodate 25% of the maximum number of occupants (i.e. one (1) 10A socket outlet per every two occupants). A minimum one (1) double 10A socket outlet with integrated twin USB outlets must be provided.
Work Booths	Provide one (1) double 10A above bench socket outlet combined with twin integrated USB outlets.
Tech Bar	Provide one (1) double above bench 10A socket outlet with integrated twin USB outlets per every four (4) workstations (i.e. one (1) 10A socket outlet per every two workstations).
Learning Support	Provide one (1) 10A socket outlet with USB outlet per person to accommodate 65% of the maximum number of occupants. A minimum one (1) double 10A socket outlet with integrated twin USB outlets must be provided.
Small Collaboration Pod/ Small Meeting Room	Provide two (2) wall mounted double 10A socket outlets with integrated twin USB outlets. Table boxes may be used in lieu of wall mounted outlets in instance where the joinery is fixed or not adjacent to a partition (where approved by TAFE NSW). All table box outlets should be soft-wired and connected to a wall mounted starter socket located below the joinery.
Large Collaboration Pods/Large Meeting Room	Provide one (1) 10A socket outlet with integrated USB outlet per person to accommodate 65% of the maximum number of occupants. Table boxes are recommended in large collaboration/meeting rooms to ensure all occupants have access to centrally located power outlets. All table box outlets should be soft-wired and connected to a wall mounted or floor box starter socket located below the joinery.
Seminar/Multifunction Rooms	Provide one (1) double 10A socket outlet with integrated twin USB outlets per every 5 meters of wall. Floor boxes containing two (2) double socket outlets should be positioned evenly throughout the space in a 5 metre by 5 metre grid in rooms larger than 100m^2 (confirm requirement with TAFE NSW).

4 Technical Sections

4.5 Accessories

Specialist Learning Spaces

Dry Laboratory (8 People)

Space	Standard Allocation
General Information	Provide power outlets as noted in the project brief by TAFE NSW. The designer must assess the brief and provide power outlets to suit full utilisation of the space. Laboratories are potentially hazardous environments. Based on the intended use of the space, the designer must assess the requirement for IP rated power outlets.
Fixed Workstation Power Allocations	For dry laboratories with fixed island benches, bench mounted service poles or power rails should be considered. TAFE NSW preference is for all electrical cabling to be concealed. Electrical cabling may be reticulated from the ceiling via an umbilical cord at TAFE NSW approval. The quantity of outlets required must align with the project brief requirements provided by TAFE NSW. Generally, consultants/contractor must provide minimum one (1) 10A socket outlet with integrated USB outlet per seated bench position, rounded up to the nearest double socket outlet with twin USB outlet.
Non –fixed Workstation BYOD Power Allocations	The designer should use ceiling mounted services poles or pendant power outlets in applications where wall or bench mounted power outlets are not suitable or as identified by TAFE NSW in the project brief. Generally, consultant/contractor must provide one (1) retractable pendant 10A socket outlet per a workstations/desk not adjacent to a wall for BYOD devices. The quantity of outlets required must align with the project brief requirements provided by TAFE NSW.

Wet Laboratory (8 People)

Space	Standard Allocation
General Information	Provide power outlets as noted in the project brief by TAFE NSW. The designer must assess the brief and provide power outlets to suit full utilization of the space. Laboratories are potentially hazardous environments. Based on the intended use of the space, the designer must assess the requirement for IP rated power outlets.
Fixed Workstation Power Allocations	For wet laboratory with fixed island benches, bench mounted service poles or bench mounted power outlets should be considered. TAFE NSW preference is for all electrical cabling to be concealed. The use of umbilicals to reticulate electrical cabling from the ceiling is prohibited in wet laboratory application. The quantity of outlets required must align with the project brief requirements provided by TAFE NSW. Generally, consultants/contractor must provide minimum one (1) 10A socket outlet with integrated USB outlet per a seated bench position, rounded up to the nearest double socket outlet with twin USB outlets.
Non –fixed Workstation BYOD Power Allocations	The designer should use ceiling mounted services poles or pendant power outlets in applications where wall or bench mounted power outlets are not suitable, or as identified by TAFE NSW in the project brief. Generally, consultant/contractor must provide one (1) retractable pendant 10A socket outlet per a workstation/desk not adjacent to a wall. The quantity of outlets required must align with the project brief requirements provided by TAFE NSW.

4 Technical Sections

4.5 Accessories

Kitchen Hospitality

Space	Standard Allocation
General Information	Provide IP56 outlets matching rating and number of phases for each item of equipment located below bench and stainless steel outlets located above bench matching the rating for each item of equipment. The quantity of outlets required must align with the project brief requirements provided by TAFE NSW.

Staff Spaces

Space	Standard Allocation
Open Office General Workstations	Provide two (2) double 10A socket outlets with integrated twin USB outlets mounted above bench on a modular power rail per a workstation as a minimum.
Open Office Specialist Workstations	Confirm detailed requirements with project stakeholders.
Kitchen and lunchroom	Provide two (2) 10A double outlets above bench and provide an outlet to each kitchen item of equipment matching the rating required. Provide the equivalent of one (1) 10A double socket outlet with combined USB outlet for each lunchroom table.

Ancillary Spaces

Space	Standard Allocation
Corridors	Provide one (1) 10A cleaner outlet every 15m linear metres
Amenities	Provide hand dryer outlet or permanent connection. Provide one (1) 10A cleaner outlet per space
Plantrooms	Provide one (1) IP56 socket outlet in close proximity to switchboards and plant equipment
Security Equipment	Co-ordinate all requirements for security power supply with security requirements. Common requirements include: Alarm panel & expander boards - provide alarm panel and expander board outlets at each location CCTV POE requirements

4 Technical Sections

4.6 Wiring Installation

4.6.1 Summary

Electrical wiring must be provided in accordance with this Design Standard for all projects including:

1. New building works
2. Renovations or refurbishment of existing buildings
3. Major or minor furniture, equipment or workstation replacement programs

Cabling selection and wiring installation methods must be provided in accordance with NCC/BCA, AS/NZS 3000 and AS/NZS 3008.1

Spare capacity for electrical cabling must be provided as follows:

1. Main electrical supply cables – 30% spare capacity
2. Sub-main electrical supply cables – 20% spare capacity
3. Light and power electrical sub-circuit cables – 20% spare capacity

4.6.2 Design

Design Calculations

Utilise PowerCAD software to validate the design methodology to AS/NZS 3000 and AS/NZS 3008.1 for the following:

1. Cable sizing and selection in accordance with proposed installation method
2. Cable tray and conduit sizing
3. Voltage drop calculations
4. Fault level calculations
5. Fault loop impedance

Utilise PowerCAD software to perform over current and short circuit protection calculations to validate each circuit breaker selection, trip unit and settings for the proposed electrical installation.

Provide time/current coordination curves for each selected circuit breaker to demonstrate the proposed electrical design has achieved the grading fault protection and discrimination for each protective device.

In addition, utilise PowerCAD software to estimate the power factor correction and active harmonic filter sizing.

Cables

Multi-stranded electrical cables with copper conductors must be used on TAFE NSW projects except for supply authority service mains.

Main Electrical Supply Cables

All main electrical supply cables must be fire rated to WS52 in accordance with AS/NSZS 3013 when serving safety services in accordance with NCC/BCA and AS/NZS 3000.

Main electrical supply cables mounted on a cable tray installation within internal carpark areas must be fire rated to WS53W in accordance with AS/NZS 3013 when serving safety services in accordance with NCC/BCA and AS/NZS 3000.

4 Technical Sections

4.6 Wiring Installation

Where a substation is located on site, consumer mains routes must be minimised and the maximum cable length must be compliant with network standards.

When underground service mains are served from a network substation the total route length to the main switchboard must be less than 50m in length in accordance with the NSW Wiring and installation rules.

All main electrical supply cables must incorporate a minimum 30% spare capacity for future growth.

Submain Electrical Supply cables

All submain electrical supply cables must be fire rated in accordance with NCC/BCA and AS/NZS 3000 when serving safety services.

All submain electrical supply cables must incorporate a minimum 20% spare capacity for future growth.

Minimum Cable Sizes

The cross sectional areas of all cables must be selected based on the following minimum requirements:

1. Lighting sub-circuits: 1.5 mm^2
2. Power sub-circuits: 2.5 mm^2
3. External circuits: 4 mm^2
4. Sub-mains: 10 mm^2

Minimum light and power cabling must incorporate a minimum 20% spare capacity.

Voltage Drop

All submains and final sub-circuit cables must be selected within the voltage drop parameters dictated by the route length and load.

All consumer mains, building mains and submains cabling must be sized and derated according to their installation method as per AS/NZS 3000 and AS/NZS 3008.

All consumer mains, building mains, submains and final sub-circuits must be designed in accordance with the *Voltage Drop Design Criteria Table*. Where the TAFE NSW site is fed from an on-site substation the total voltage drop must not exceed 7%. Where a TAFE NSW site is fed from an underground or aerial service main, the total voltage drop must not exceed 5%.

Voltage Drop Design Criteria Table

Cable Type	Maximum allowable voltage drop (%)
Consumer Mains	0.5%
Building Mains	2.5%
Submains	1.5%
Final Sub-circuits	2.5%

4 Technical Sections
4.6 Wiring Installation

Fault Loop Impedance

All submain and final sub-circuit cables must satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions, as per AS/NZS 3000.

Power Circuiting Requirements

All circuits for power outlets must be:

1. Installed with a maximum of 6 off 10A socket outlets in kitchen preparation areas
2. Installed with a maximum of 6 off 10A socket outlets in non-air-conditioned areas (e.g., car park, plant room)
3. Installed with a maximum of 12 off 10A socket outlets in air-conditioned areas
4. Installed to AS/NZS 3000 so that each 10A double outlet should be considered as two socket outlets
5. Provided with an individual circuit for each item of permanently connected equipment
6. Provided with an individual circuit for each socket outlet rated 15A or over
7. Provided with circuit socket outlets from the respective starter socket to have a maximum of 24 outlets or 6 workstations (with a maximum of 4 outlets per workstation) per 20A circuit

Lighting Circuiting Requirements

Refer to TAFE NSW Lighting Services Design Standard.

4.6.3 Components

Soft Wired Systems

A soft wiring system must be provided within workstation and/or desks which are movable and not fixed.

The soft wiring installation must comply with AS/NZS 3000, AS/NZS 61535.1, AS/NZS 3131, AS/NZS 3100 and AS/NZS 3112 as relevant to the component parts and be compatible with workstation furnishings and fixtures.

All connection devices in the soft wiring system must have a positive mechanical connection feature which requires the use of a tool for disengagement and disconnection of the plug and socket.

Starter Sockets

All starter sockets should be rated to a minimum of 20A and connected to a dedicated circuit. All starter sockets must be mounted in position to a permanent building component so that they are not disturbed in the event of removal of the equipment served by the soft wiring system.

Interconnecting Leads

All interconnecting leads from between the starter socket and cascaded socket outlets must be rated to a minimum of 20A, comprise of flexible cables with stranded copper conductors of a minimum 2.5mm^2 cross sectional area and fitted with plug and socket couplers.

4 Technical Sections

4.6 Wiring Installation

Interconnecting leads must be concealed from normal view and enclosed within workstation/joinery wiring compartments and fixed in position with plastic cable ties or purpose made clips.

Intermediate couplers must not be used.

Joinery and Workstation Cable Management

All workstations and joinery must be provided with under bench cable management as required. The requirement for under bench cable management must be coordinated with the architect and/or TAFE NSW and provided by the workstation/joinery manufacturer.

Electrical cabling must be reticulated from a floor box to the joinery/workstation via a rigid umbilical cord with separate compartments for power, communications and other cabling. The umbilical cord must be fixed at both ends.

Electrical cabling must be reticulated from the ceiling to the joinery/workstation via a rigid umbilical cord or cable trunking with separate compartments for power, communications and other cabling. The umbilical cord must be fixed at both ends.

Heritage Building Wiring Practice

The modification of any elements within a heritage building is not permitted without prior approval from the heritage consultant and must be included within the project return services brief for TAFE NSW approval. This includes, but is not limited to:

1. Chasing of heritage walls or slabs
2. Visible conduits and cable trays

All modifications should be minimised to protect the heritage aspects of the building. Where visible conduits and cable trays are unavoidable, their use must be minimised. All visible components must be run in direct horizontal or vertical lines.

Conduit Systems

General

All conduits must be:

1. Installed using the loop in system
2. Free from conduit fittings other than junction boxes, wall boxes, bends or couplings
3. Concealed conduits must be 20 mm minimum diameter. Oval or rectangular concealed conduits are unacceptable
4. Concealed from view by running in ceiling spaces, concrete slabs, air space of stud or double brick, or block, walls or chased into rendered masonry walls unless otherwise specified or agreed
5. Restricted to contain a maximum of two circuits with derating in accordance with AS/NZS 3008
6. Provided with a 3 mm diameter, minimum, nylon cord where specified for future wiring or wiring for other trades
7. Comply with relevant sections of AS/NZS 2053

4 Technical Sections

4.6 Wiring Installation

Exposed Conduits

Conduits exposed to view must be:

1. Installed in straight runs which are parallel or normal to the building structure over agreed routes
2. Secured by spacer bar type saddles grouped in symmetrical positions providing 3 mm clearance of the fixing surface
3. Painted a selected colour, as nominated by the project design team
4. Non-painted in industrial environments, as nominated by the project design team

Flexible Conduits

Flexible conduits must be:

1. Heavy duty PVC
2. Anaconda type flexible steel conduit where subject to mechanical damage or required for earth continuity, e.g., across construction joints
3. Provided between fixed conduit and equipment which is likely to be moved or subject to vibration
4. Fitted with brass or nylon terminators
5. Connected to concealed fixed conduits via a flush mounted junction box with a terminator secured by locknuts to the cover plate
6. Not used in concrete walls or slabs unless otherwise approved
7. A maximum of 500mm in length and neatly arranged to minimise length.

Steel Conduits

Steel conduits must be:

1. Galvanized
2. Cut square, threaded with the minimum number of threads being cut consistent with the union, painted over the threads with conductive paint, reamed to remove burrs, and adequately terminated into threaded connections or lock nuts with no threads showing after assembly. Proprietary alternative systems to threaded connections may be offered for approval where they provide equal or better performance to threaded connections
3. A proprietary system including Locfit or similar tapped systems that do not require threading. Compliance with performance requirements for security of connection, removal of burrs (if any), electrical continuity of the connection, and protection against corrosion, remain requirements of any alternative to a threaded system
4. Fixed at 1200 mm (maximum) centres where surface run.

Rigid PVC Conduits

Rigid PVC conduits must be:

1. Of high impact, cold setting, light duty
2. Jointed together and to fittings with an approved solvent cement
3. Not used in the following locations:
   - Where exposed to mechanical damage
   - Where subject to ambient or contact temperature in excess of 50°C
   - In hazardous locations
   - In areas where there is significant risk for mechanical damage

4. Provided with one approved expansion joint for each straight section of surface run conduit exceeding six (6) metres in length
5. Secured in position by approved saddles spaced at 1000 mm, maximum, apart
6. Provided with saddles fastened to the side of a timber batten where installed across rafters or joists in accessible ceilings

Corrugated Conduits

Corrugated conduits must be:

1. Manufactured from PVC resin
2. Compressive tested to meet the requirements equal to Category A rigid PVC conduit
3. Assembled with accessories which comply with IP65 rating as per AS 60529 to exclude dust and water
4. Not used for general wiring where exposed to view unless where terminating at equipment not normally moved, i.e., solenoid valves
5. A maximum of 500mm in length and neatly arranged to minimize length

Cable Trunking

All cable trunking must be:

1. Fabricated from not less than 0.8 mm thick galvanised steel
2. Not be less than 75 mm x 50 mm in cross section and should be filled with cables to not more than 50% of its useable capacity
3. Be employed to replace multiple runs of conduit in accessible locations in addition to the instances where specifically indicated, providing that this does not incur additional cable derating factors as per AS/NZS 3008, to reduce the current rating below the rating of the specified protective device
4. Equipped with screw fixed readily removable covers, of maximum length 1200 mm
5. Provided with removable cable retaining straps along the length, to permit covers being removed and replaced without interference to the cables enclosed
6. Equipped with couplings between adjacent lengths, to facilitate electrical conductivity and mechanical union
7. Fitted with integral partitions throughout the length of ducting, where it is necessary to accommodate services of different voltages, frequencies or natures within a common trunking run, such that each service should be mutually segregated and completely surrounded by earthed metal
8. Installed in straight runs true, horizontal or perpendicular to reduce the number of bends and sets to a minimum
9. Run square or parallel to the building lines
10. Fitted with purpose made bends, sets, end sections and intersection pieces as required and formed with gussets such that the effective wiring space is maintained
11. Supported at intervals not exceeding 1200 mm
12. Installed complete with all requisite accessories
13. Be supported such that the maximum deflection between supports does not exceed 10mm when fully loaded

4 Technical Sections

4.6 Wiring Installation

Skirting Wiring Duct

All skirting wiring ducts must be:

1. Manufactured from extruded aluminium section
2. A nominal size of 150 mm x 50 mm
3. Provided with segregated wiring compartments for voice/data, power and miscellaneous cabling
4. Suitable for surface mounting or recessed within partitioned walls
5. Fitted with front cover plates of 1 mm mild sheet steel of maximum length 2000 mm over extruded duct
6. Finished in powdercoat of selected colour, as agreed with the project design team
7. Recesses with fishplates or dowels to align duct sections at joints
8. Fitted with diecast metal or moulded plastic end plates
9. Fitted with separate short length lid outlet sections die punched to receive a power or telephone outlet
10. Supplied with adequate feeder conduits such that the full cross sectional area of each compartment is available for current and future wiring
11. Provided with no significant air gaps
12. Appropriately secured

Cable Ladder/Trays

Cable ladder/trays must be:

1. Fire rated WS52 to AS/NZS 3013 when serving fire services and WS53W when located in carpark areas
2. Perforated sheet steel electro zinc plated with minimum 50% of the surface area open for air circulation
3. Fitted with the manufacturer's standard bends, risers, curves, reducers and fishplates
4. Fixed to steel brackets and hangers to provide a rigid fixing
5. Fixed such that there is sufficient air space between the structure and the tray to which they are secured enabling natural air circulation to occur and for cable access
6. Supported such that the maximum deflection between adjacent supports does not exceed 10mm when fully loaded to the ultimate capacity provided with a 2:1 safety factor
7. Free from sharp edges or corners
8. Installed parallel or at right angles to the building structure and planning grids
9. Sized so that they are loaded a maximum 80% of their capacity, width, including spaces between cables for derating purposes without undue bunching
10. Provided with sun screens where exposed to sunlight
11. High sided type for cable loads in excess of 20 kg per metre
12. Located where maintenance access is readily available
13. Sized to allow at least 20% spare capacity within main cable tray runs

4 Technical Sections

4.6 Wiring Installation

Sealing of Penetrations

Fire Rated Structure

Any penetration must be fire sealed with a certified approved fire sealing method to maintain the fire rating of the wall, floor or ceiling structure. All fire sealing methods must be reviewed and approved by the project Crown Certifier prior to procurement.

All fire sealing of penetrations must be permanently labelled with date, contractor and certifier details.

Outlets located on fire rated wall boxes must be provided within fire rated walls.

Acoustic Element

Any penetration including outlets must be addressed in accordance with acoustic report requirements. Avoid back to back outlets and offset in accordance with acoustic requirements or otherwise provide acoustic wall boxes.

Waterproof Element

Any penetration of waterproofing elements including damp-proof courses, waterproofing membranes, roof coverings and the like must be provided with an approved waterproof seal between the membrane and the penetrating component.

Underground Service

General

Undertake a feasibility assessment and submit method of underground service by boring or trenching to TAFE NSW prior to works commencing for review.

The underground service method of installation should identify:

1. Employ a “services finder” to locate all underground services prior to commencing any excavation on site to prevent services being damaged by works carried out
2. Minimise the disruption to carpark entrance/exit and loss of car spaces
3. Underground boring is preferred where possible to avoid the breaking/damaging of existing surfaces
4. Alternatively, trenching works must include cleaning, excavation, back filling and consolidation of the trenches including compaction and reinstatement of surface, paving or sealed areas
5. Set-out route proposed on site must be coordinated with structural, civil, landscaping and all underground services identified and pre-marked for review by the TAFE NSW project lead.
6. Final route to incorporate brass markers at each joint, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 100 m
7. Trench widths, depths and pit locations must be surveyed on site
8. Conduits, pit arrangements and routes must be in accordance with AS/NZS 3000 and derating of underground cables to AS/NZS 3008
9. All sizes of underground conduits dedicated for mains, sub-mains, external lighting and services or spare
10. All underground conduits/ducts installed and sealing method to prevent any ingress of moisture at building entry penetration

11. Any saw-cutting of existing concrete and bituminous surfaces
12. Method to lift and store unit paving for later reinstatement
13. Trenching requirements near tree protection zones identified by arborist with the inclusion of any hand digging required
14. All excavation work must ensure the site is left clean and tidy at any time and all excess material and spoil is removed from site

Cable Pits

All pits must:

1. Be sized to allow cable bending radii
2. Incorporate heavy duty rated lids suitable for heavy vehicle loading with chequer plate galvanised steel covers fitting with lifting method
3. Incorporate a conduit system which must be vermin and pest resistant, with appropriate drainage
4. Incorporate space to facilitate clean out, cable hauling and the like
5. Be provided with a client numbering convention including enclosures and reticulation systems. Each pit must be stamped with a non-removable label.
6. Drainage of pit to adjacent infiltration system

Underground Conduits

When crossing or running parallel to other services, underground cabling must be spaced as required. Special attention should be given to the easement requirements of communications, gas, water, sewerage and electricity supply authorities. Hand excavation must be carried out when in the proximity of other services.

Underground conduits must be sized to allow for the installation of mains, sub-mains, sub-circuits and all associated control cabling and provision of additional spare conduit for future use.

All spare conduits must be provided with polypropylene draw cords in spare conduits with 1m of cord coiled at each end.

Installation of the underground conduits must have all joints glued using gap filling adhesive to manufacturer's specification.

The conduit set out must be coordinated with the landscaping layouts, building layouts, civil and structural underground footing works and all other proposed services and install to maintain the following spacing segregation:

1. 100mm from underground communications services
2. 100mm from underground gas and water pipes not greater than DN 65
3. 300mm from underground gas and water pipes greater than DB 65
4. 150mm from any pipes containing hot fluids
5. 50mm from other pipework

The underground conduits/ducts installed are to be sealed off to prevent any ingress of moisture.

4 Technical Sections

4.6 Wiring Installation

4.6.4 Deliverables

Design Deliverables

The consultant or designer must provide specifications for cable selection and installation methods for the area or space.

Each cable selected must be presented within schedule indicating the following:

1. Number of cores
2. Cable gauge
3. Insulation type
4. Cable laid format to be quadfoil
5. Installation cable management
6. Route underground or above ground
7. Origin and destination

Installer Deliverables

Submission of workshop drawings must include:

1. Final mains and submain route coordinated with power layouts at scale of 1:100
2. Sub-circuit wiring to final light and power circuit including cable size for the proposed installation
3. Installation cable management
4. All technical data sheets

4 Technical Sections

4.7 Electromagnetic Interference and Compatibility (EMI and EMC)

4.7.1 Summary

EMI & EMC must be provided to all works including:

1. New building works
2. Major works projects including refurbishment of existing buildings

To mitigate ELF EMI must be provided by:

1. Separation of electrical infrastructure
2. Arrangement in quad foil of mains, submains, three phase cabling and the like
3. Shielding of specialist equipment
4. In-line filtration of equipment

4.7.2 Design Guidelines

The design of the electrical systems must address:

1. Substations and main switchrooms must be located at least 10m radial sphere from occupied rooms in particular laboratories, teaching spaces and staff office/meeting rooms
2. Main or sub-main routes or risers located within the building must be located with a minimum separation of 5m from occupied areas
3. Specialist equipment requiring EMI fields less than 2mG must have an EMI specialist involved in the concept design phase
4. Shielding of the sources or receptor is not a preferred option

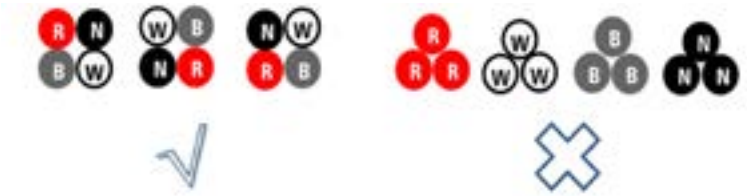
4.7.3 Components

ELF EMI Mitigation

Switchboard design and cabling installation of mains, submains and cabling must be configured to maximise the natural cancellation of magnetic fields of conductors utilising the following methods:

1. Switchboard busbar configurations minimising the allowable clearances between phases and between phases and neutral busbars
2. Using three phase cabling in preference to three single cables. Assess and utilise four (4) active and neutral cores with the additional earth up to a size selection where cabling installation can be achieved within the physical building spatial constraints
3. Cables to be tied to maintain a quad foil configuration of phases to mitigate the distance between cores where installed on overhead ladders
4. Locate trays and cabling reticulation to maximise distance where within close proximity from neighbouring ELF EMI sensitive areas including security metal detectors, security equipment and all medical services equipment in accordance with AS 3003 and allow to locate all cabling outside the zone of influence

5. Distribute all single-phase electrical loads evenly between three phases for each mains and submain and final three-phase sub-circuit supply
6. Tie all mains, submain or sub-circuit three phase cabling circuit groupings together in quad foil formation when installing within underground conduit



7. Avoid dedicated phase by phase groupings of single cores in parallel instead provide circuit groupings as indicated in diagram below:

ELF Magnetic Field Shielding

Review specialist equipment to make an assessment of the specific acceptable magnetic field intensity that can exist within close proximity of the equipment.

Where switchboards or submains/mains are in close proximity to specialist equipment, then a detailed design of the EMF shielding must be provided to attenuate the magnetic field to an acceptable level as specified within the technical specification.

Provide all EMF test measurements within the areas where specialty equipment exists.

Power Line Filtration

An assessment within each laboratory area must be undertaken to identify where high frequency EMI (10kHz – 10GHz) should be generated from specialist laboratory equipment, or where laboratory equipment is prone to EMI sensitivity within the laboratory. Where this is identified a dedicated distribution board must be provided within the laboratory. This DB must include whole current pass-through passive power line filters on the sub-mains.

4 Technical Sections

4.8 Earthing Systems

4.8.1 Summary

The earthing installation design is required to be provided to all works including:

1. New building works
2. Renovations or refurbishment of existing buildings
3. Minor and Major furniture or workstation replacement programs

This section applies to the Low Voltage (LV) Earthing system of the installation for the safety of operators and the correct function of equipment including:

1. MEN earthing
2. Technical Earthing
3. Earth bonding

4.8.2 Design

The earthing design must be in accordance with the following regulations and standards:

1. Network Distributor “Distribution Earthing Design”
2. Service and Installation Rules of NSW
3. AS/NZS 3000
4. AS/NZS 3003

Computer modelling calculations using current distribution, electromagnetic fields, grounding and soil structure analysis (CDEGS) should be used to design, test and verify the earthing system.

4 Technical Sections

4.8 Earthing Systems

4.8.3 Components

MEN Earthing

A separate earthing system should be provided for LV electrical systems.

Provide a MEN earthing system to earth effectively the main switchboard, all distribution boards, fixed and general purpose outlets, luminaires and all other equipment as required by AS/NZS 3000, service and installation rules and TransGrid requirements.

The main earthing conductor should be connected to a commercial earthing electrode, which should be installed to the requirements of the supply authority.

The earthing electrode should be in one piece and consist of a solid steel core rod bonded to an outer casing of electrolytic copper. The rod should be of minimum 2.4m length and minimum 25mm diameter.

Where the electrode is installed in rock it should be installed in a hole of minimum dimensions 50mm diameter and 2.4m deep drilled into the rock. The vacant space around the electrode should be packed with a mixture of bentonite, clay and gypsum.

The main earthing conductor should be connected to the earthing electrode by means of an approved earthing clamp. The connection should be carried out in a pit or core hole.

The main earthing and bonding conductors should be sized as required by AS/NZS 3000 and should comprise PVC insulated copper cables in conduit.

Technical Earthing

The technical earthing system must incorporate:

1. A dedicated buried earth grid external to each building to achieve a maximum impedance to satisfy communication rack and specialty laboratory equipment requirements
2. An alarm monitoring for earth leakage/circulation current on the link to the main earth bar
3. A dedicated communications technical earth bar with the provision to clamp a current meter for every outgoing radial cable
4. A single link to the building main earth bar in the building main distribution board or the campus main switchroom
5. A dedicated technical earth cable distribution to every dedicated audio-visual distribution system, communication equipment room and all laboratory equipment

4 Technical Sections

4.8 Earthing Systems

Earth Bonding

As a minimum, the LV earth should be bonded to the following parts in accordance with the manufacturer's specifications:

1. Transformer neutral taps
2. LV neutral and/or metallic screen
3. Metallic water pipes
4. LV surge arrester
5. LV aerial neutral
6. LV only butt plate and earth ferrule
7. Raised floors
8. All metallic building elements connected radially to the power protective earth bar
9. Incoming cold-water supply pipe where it enters the building
10. All metallic cable support systems including cable trays, skirting ducts, wall studs, roof trusses, steel covers, removable escutcheon panels housing electrical and control cabling should be earthed in accordance with AS/NZS 3000

Specialised Earthing

In addition to the above, 'special earthing' requirements within cardiac protected areas are to be provided in accordance with AS/NZS 3003.

4.8.4 Deliverables

Design Deliverables

The consultant or designer must provide specifications for earthing requirements and bonding installation method for the area or space.

Installer Deliverables

Submission of workshop drawings must include:

1. Earth bar details including destination and cable size connection
2. Earth Bonding details and locations on plan at scale 1:100
3. Earthing Electrode details
4. All technical data sheets

4 Technical Sections

4.9 Lightning Protection System

4.9.1 Summary

A lightning protection system is required to be provided to all works including:

1. New building works
2. Renovations or refurbishment of existing buildings where the existing lightning protection system does not meet current standards

The lightning protection system must be provided to protect areas exposed to lightning strikes which include, but are not limited to, the following:

1. The roofs of buildings
2. Objects protruding above or mounted upon building roofs
3. All projections, flues, ventilation exhausts, antenna communication systems and all other aerial/mast head arrays
4. All lighting and security equipment poles
5. All exposed services equipment including external switchboards, kiosk transformer housings, generator enclosures, above ground tanks and the like services equipment
6. External perimeter and compound fences

4.9.2 Design

Concept Design

Undertake a lightning protection risk assessment in accordance with AS/NZS 1768 where lightning protection works are required to be undertaken.

Provide a scope of works for a compliant lightning protection system in accordance with AS/NZS 1768 and AS/NZS 3000 within the return services brief.

Site Investigation

Where an existing building is proposed to undertake a significant refurbishment, additions and or alterations then the design consultant must:

1. Assess the existing condition of the system and its compliance with current standards
2. Identify scope of additions, alterations, modification or repairs required to satisfy compliance
3. Provide a budget estimate to undertake the works and include within the return services brief

Design Development Drawings

Develop the design in accordance with AS/NZS 1768. Include plans, sections, elevations, identify types of earthing connections to building structure, earth bars, or the like prior to work commencement.

4 Technical Sections

4.9 Lightning Protection System

4.9.3 Components

Protection of Building Roof

Provide strapping along the perimeter of concrete parapet roofs and provide finials connected to down conductors in accordance with AS/NZS 1768.

Where metallic roof is provided make assessment in accordance with AS/NZS1768 whether this should act as the effective air terminal.

Provide a down conductor cable from the metal structural roof beam to the earth electrode pit within a 50mm conduit. Attachment should be by Cadweld connection.

All metal roof areas should be bonded with copper or stainless steel tape across various levels of non-metallic continuous roof sections and also to connect the tape at different roof levels.

Provide attachments to down conductor columns as part of this work with the same method of attachment.

Fix the roof tape to the building structure at the required intervals using similar metal fixing clamps.

Joints in the tape should be by means of a purpose-made straight, Tee or 4-way clamp.

Bond all projecting metal such as flues, exhaust stacks, antennae/aerials, masts and any other roof mounted equipment which fall outside the zone of protection as defined by AS/NZS 1768.

Provide expansion loops in horizontal air terminations/conductors between fixing points.

Down Conductors of Buildings

Down conductors: The down conductor methodology should vary across each building within a TAFE NSW campus. The down conductors should comprise of:

1. Structural steel columns or
2. Cable or tape down conductor connected to footings and/or earth electrodes

Bonding:

1. Structural steel column footings to be connected to the earth electrode system

Earth Terminations

1. Foundation or footing bonding: provide threaded terminals welded to reinforcement. Bond to foundation reinforcement using wire ties and two (2) welded connections. Bond the footing structural steel to column structural steel
2. Bond each down conductor with footing or directly to electrode system in accordance with AS/NZS 1768
3. Locate driven earth electrodes in dedicated pits. Mark pit covers with the words Earth Electrodes
4. Provide test points comprising of concrete pits complete with lids.

4 Technical Sections

4.9 Lightning Protection System

General Bonding Requirements

1. Bonding to be achieved utilising cadweld or equivalent. All materials used should be assessed for compatibility to minimise galvanic action
2. Bond the lightning protection earthing system to the MEN earthing electrode and all buried metallic service pipes entering the building using bare cable buried underground
3. Bond all pipe risers, down pipes, metal masses and incoming underground or above ground metal pipes in accordance with AS/NZS 1768
4. Bond all metallic materials that cannot be maintained at a clearance of 50 mm from the lightning protection system
5. No bonding connections should be of dissimilar metals

Lighting and Security Poles

All lighting and security posts are effectively lightning finials. The galvanised steel poles act as the lightning protection down conductor. The baseplate of the pole is connected to the footing where the rag bolt assembly bonds to the footing reinforcement. Typically, no additional lightning protection should be required.

External Exposed Services Equipment

External mounted switchboards must be provided with a lightning protection connection tag. A lightning bonding strap from the switchboard metallic enclosure should be directly connected to the earthing electrode.

Kiosk substation enclosures must be provided with a lightning protection connection tag. A lightning bonding strap from the kiosk metallic enclosure should be directly connected to the substation main earthing electrodes.

Generator substation enclosures must be provided with a lightning protection connection tag. A bonding strap from the generator enclosure should be directly connected to earthing electrode.

Above ground tanks must be provided with a lightning protection connection tag. An earth PVC cable from the above ground tank should be directly connected to earthing electrode.

External Perimeter Fences

All perimeter fencing including metallic mesh and support posts are effectively lightning finials. The galvanised steel poles and mesh act as the lightning protection down conductor. The baseplate of the post is bonded to the footing assembly and footing reinforcement which serves as an earth rod. Typically, no additional lightning protection should be required.

Cabling

The following cabling types should be utilised:

Main earth cable connected to earth bar: Two (2) off 70mm^2 copper PVC insulated cables Cadweld to perimeter earth grid and lug with bolt connection to main earth bar. Maintain 5m separation between paths.

Interconnecting cables to each earth electrode pit: 70mm^2 copper cables buried 600mm deep interconnecting each earth electrode forming an earth grid around the perimeter of the building.

4 Technical Sections

4.9 Lightning Protection System

Down conductor: 70mm^2 copper PVC insulated cables Cadweld connecting the roof structural beam and earth electrode.

Structural footing and slab reinforcement: 35mm^2 copper bare cabling Cadweld connection to structural footing or slab reinforcement.

Fence footing reinforcement: 35mm^2 copper bare cabling Cadweld connection to structural footing reinforcement.

Bonding conductor to metallic elements above ground: 16mm^2 copper PVC cable to provide equipotential bonding to each above ground elements as indicated on drawings for each building:

Electrode Pits

Locate driven earth electrodes in the nominated locations within concrete pits.

Earth rods should be solid copper rods minimum 25mm dia and 2400mm long. Length of the electrode should be subject to final site condition at each building location.

Lightning protection pits must be provided with identification.

4.9.4 Deliverables

Design Deliverables

The consultant or designer must provide specifications for lightning protection requirements and the bonding installation method for the building.

Installer Deliverables

1. Submission of workshop drawings must include:
   - Down conductor, earth bonding and test point locations on plan at scale 1:100
   - Earth bar details including destination and cable size connection
   - Earthing electrode details
   - All technical data sheets
   - Locations on plan at scale 1:100
2. At the completion of the lightning protection earthing installation the installer should test the resistance to earth of the entire lightning protection system from each air termination to earth and ensure compliance with AS/NZS 1768 inclusive of all buildings, perimeter fences, lighting and security poles and all external exposed services as described above
3. Training and maintenance must include the following:
   - Preventative maintenance procedure
   - Shop and as-installed drawings
   - Operational and maintenance procedures and as built drawings

4 Technical Sections

4.10 Work Health & Safety

4.10.1 General Requirements

The ''Common Work Health & Safety Concerns'' table identifies common Work Health & Safety concerns arising from electrical services that have been identified from past TAFE NSW projects. Each project team must demonstrate that all safety concerns raised have been addressed as part of their involvement with any project to which this Design Standard applies. The safety concerns listed in the table must be included in project-specific Safety-in-Design Registers to ensure that project teams demonstrate how they have been addressed through all phases of any project.

Please note the information in the table is:

- For guidance only,
- Not exhaustive and does not take into account specific circumstances and should not be relied on in that way, and
- Does not alleviate the respective TAFE NSW team, designer, supplier or contractor from their own Work Health and Safety obligations and duties.

Legend	Level of Risk	Action Required
H	High	Implement cost effective risk control measures, and formalise procedures or management responsibility for reducing risk. Amend design to reduce risk, or seek alternative option. Only accept option if justifiable on other grounds.
M	Moderate	Incorporate cost effective risk control measures within the scope of long-term planning. Management responsibility must be specified. Check that risks cannot be further reduced by simple design changes.
L	Low	Manage by routine procedures. Check that risks cannot be further reduced by simple design changes.

4 Technical Sections

4.10 Work Health & Safety

4.10.2 Common Work Health & Safety Concerns

Safety Concern Raised	Potential Control or Treatment measure	Reference to Design Standard/ Statutory Requirements	Level of Risk	Phase - Project Delivery	Phase - Design	Phase - Construct, Supply, Install	Phase - Operation and End use
Outage complaints	Design to consider portable generator option where historically network outages are common	Clause 4.1	H	-	Y	-	-
Water leaks into rooms	Design of rooms to be water tight so that no leaks occur within room. No water services to be provided in switchboard residing in rooms, cupboard areas.	NCC/BCA	H	-	Y	-	-
Failure of switchboards	Switchboard design to allow thermal scanning of switchboards to be carried out safely to be carried out periodically.	AS/NZS 61439.1, AS/NZS 61439.2	M	-	Y	-	Y
Lack of power outlets means that excessive power boards used outlets within room	The TAFE NSW Standard provides the minimum quantity of outlets and the project design team will ensure that the number of outlets is maximised depending upon number of circuits & BYOD policy.	AS/NZS 3000	M	-	Y	-	Y
Damaged power outlets	Power outlet locations to be positioned to minimise damage.	AS/NZS 3000	M	-	Y	Y	-
DB missing pole covers and schedules	Inspections required after work on switchboards.	AS/NZS 3000	M	-	-	-	Y
Tag testing not provided to equipment	Statutory inspections to be carried out.	AS/NZS 3000	M	-	Y	-	Y
Emergency Power Switches	Design to include Location Emergency Stop within workshop and laboratory type areas in locations readily available to allow staff to shutdown power in the event of an incident.	AS/NZS 3000	M	-	Y	-	-
Floor boxes use	Floor boxes to include cable protecting flap to protect wiring. When surface mounted locate to avoid tripping hazard. When recessed provide fire rating cover to maintain fire rating integrity of slab. Locate only where necessary.	AS/NZS 3000	M	-	Y	-	-

4 Technical Sections

4.10 Work Health & Safety

Safety Concern Raised	Potential Control or Treatment measure	Reference to Design Standard/ Statutory Requirements	Level of Risk	Phase - Project Delivery	Phase - Design	Phase - Construct, Supply, Install	Phase - Operation and End use
Access to PV for cleaning	Architectural Specification should include safe roof access points within roof location for PV maintenance access.	NCC/BCA	H	-	Y	-	-
EDB access	EDB access to be readily accessible by maintenance staff in accordance with Australian Standards. EDB to be provided in lockable cupboard. Do not locate EDB cupboard on fire rated wall.	NCC/BCA	M	-	Y	-	-
Ability to tamper with/ move power outlets on skirting ducts	Tools required or similar to minimise tampering by unauthorised people.	Clause 4.6	M	Y	Y	-	Y
Damage to Overhead cabling	All cabling to be trenched trenched underground within campus serving buildings and no permanent overhead cabling will be permitted.	Clause 4.6	M	Y	Y	-	-

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