

# Minimum Design Standard - Electrical Services

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# 1 Overview

## 1.1 Design Principles

This Minimum Design Standard (MDS) sets out the Northern Territory Government's (NTG's) minimum requirements for the design of electrical services for all NTG non-residential buildings. Unless specified by the NTG Department of Logistics and Infrastructure (DLI) Electrical Services group, all statements made in this document shall be understood to be the minimum requirement. The engineer undertaking electrical designs for NTG is required to produce their own drawings and specifications based on this MDS, that either meet or exceed the requirements of the MDS. Written permission must be provided by the NTG Project Superintendent (hereafter referred to as the 'Superintendent') if the design engineer wishes to deviate from the requirements of this MDS. This MDS must be read in conjunction with all relevant Australian Standards, statutory regulations, and codes. If there are any discrepancies between any documents, then the more onerous, and/or the higher quality, and/or the higher standard, and/or the more comprehensive requirement takes precedence.

## 1.2 Inclusions and Exclusions

This Electrical Service Design MDS is divided into the key areas of the discipline considered in NTG buildings and includes:

- General Design Requirements
- General Power
- Lighting
- Data and Communications
- Access Control and Security (including CCTV)
- Fire Detection
- Generator and backup power
- Photovoltaic Systems

It does not include:

- HV distribution technical design requirements – refer Power and Water Corporation (PWC) standards and specifications. The consultant is still required to undertake design for network upgrades for the building works if deemed a requirement by the authority.
- Specifications for front end end-user equipment e.g. monitors, TVs, projectors, AV media systems, white goods, etc.
- Theatrical lighting and their control systems
- AV media systems
- NTG ICT network active equipment e.g. network switches – refer latest version of the NTG Data and Voice Cabling Standard

## 2 Definitions and Acronyms

Table - Definitions and Acronyms - Minimum Design Standard - Electrical Services	
Term	Meaning
3g, 3G, 4G, 5G	Generational iterations of the cellular telephone network
A	Ampere - a measure of electrical current
AC, ac, a.c.	Alternating current
AFDD	Arc Fault Detection Device
ATS	Automatic transfer switch
BACnet	Building automation and control network
BCA	Building Code of Australia - Volumes 1 and 2 of the NCC
BMS	Building management system
CAD	Computer assisted/aided design/drafting
CCTV	Closed circuit television
CEC	Certificate of electrical compliance
Client	The department for which the project is undertaken by DLI
Consultant	The individual or company directly responsible for undertaking the obligations of any contract between them and the NT Government
Day	Working days, not including Saturdays, Sundays and public holidays
DC, dc, d.c.	Direct current
Department, The DLI	The Department of Logistics and Infrastructure (DLI) (Formerly DIPL - The Department of Infrastructure, Planning and Logistics)
DOE	Department of Education
ELV	Extra low voltage
FOBOTS	Fibre optic breakout terminal
GPO	General purpose/power outlet
HV	High voltage
HVAC	Heating, ventilation and air conditioning
ICT	Information communication technology
IP	Internet protocol
ka, kA	Kilo Amperes
kVA, KVA	Kilo Volt Amperes
LAN	Local area network
LED	Light emitting diode
lm/w, lm/W	Lumens per Watt
LV	Low voltage
MCB	Miniature circuit breaker
MWh	Mega Watt hour
NBN	National Broadband Network

Table – Definitions and Acronyms – Minimum Design Standard – Electrical Services	
Term	Meaning
NCC	National Construction Code of Australia - includes the BCA and the PCA
NTG	Northern Territory Government
NVR	Network Video Recorder
PCA	Plumbing Code of Australia – Volume 3 of the NCC
PFC	Power factor correction
Principal	Generally the Northern Territory of Australia, or the Principal stated in the Annexure to the Contract
Provide	Means give to the Superintendent where it refers to documentation. Generally PROVIDE means, supply, transport, install, connect, test, commission and leave ready for use unless the context clearly indicates otherwise. In the context of this design standard this sense of PROVIDE means to incorporate these requirements in the design and specification documentation.
PV	Photo voltaic
PWC	Power and Water Corporation
RCD	Residual current device
RFT/RFQ	Request for Tender / Request for Quotation - requirements applicable to one are equally applicable to the other
Shall	Is indicative of a mandatory requirement which must be incorporated in the design unless the context clearly indicates otherwise.
SMC	Security monitoring centre
Superintendent Principal	As defined in the contract. A reference to the Superintendent or to the Principal includes a reference to the Superintendent's Representative, or to the Principal's Representative, and to any person, or person occupying a position, nominated by the Superintendent or by the Principal, or by the Superintendent's Representative, or by the Principal's Representative, to act on their behalf in procuring the works under the contract. Any reference made in this document to NTG or DLI, means the Superintendent or Principal, and their respective representatives for the project
U/FTP	Unshielded foiled twisted pair
UPS	Uninterruptible power supply
UTP	Unshielded twisted pair
V	Volt – a measure of electrical potential difference
VAr	Volt Ampere reactive
Wi-Fi / wi-fi	Wireless fidelity – wireless network capability
Will/must	Is indicative of a mandatory requirement which must be incorporated in the design unless the context clearly indicates otherwise.

### 3 Standards

<b>Table – Referenced Australian Standards – Minimum Design Standard – Electrical Services</b>	
Use Standards, and their amendments, current as at the date for the close of tenders except where different editions and/or amendments are specified or are required by statutory authorities, including, but not limited to, NATA and the National Construction Code which includes the Building Code of Australia and the Plumbing Code of Australia.	
<b>Designation</b>	<b>Title</b>
AS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1627.4	Metal finishing - Preparation and pretreatment of surfaces - Abrasive blast cleaning of steel
AS 1657	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1670 (set)	Fire detection, warning control and intercom systems - System, design, installation and commissioning
AS/NZS 1680 (set)	Interior and workplace lighting
AS/NZS 1768	Lightning protection
AS 1891 (set)	Personal equipment for work at height
AS/NZS 2293 (set)	Emergency lighting and exit signs for buildings
AS 2344	Limits of electromagnetic interference from overhead a.c. powerlines and high voltage equipment installations in the frequency range 0.15 MHz to 3000 MHz
AS/NZS 3000	Electrical installations – (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3003	Electrical installations - Patient areas
AS/NZS 3008 (set)	Electrical installations – Selection of cables
AS/NZS 3010	Electrical installations – Generating sets
AS/NZS 4777 (set)	Grid connection of energy systems via inverters
AS/NZS 5033	Installation and safety requirements for photovoltaic (PV) arrays
AS/NZS 5532	Manufacturing requirements for single-point anchor device used for harness-based work at height
AS 60038	Standard voltages
AS/NZS 61000 (set)	Electromagnetic compatibility (EMC)
AS/NZS 61439.1 (set)	Low-voltage switchgear and controlgear assemblies (Supersedes AS/NZS 3439. Transition period ends 2021)
AS 62040	Uninterruptible power systems (UPS)



## 4 Designer's Requisite Skills and Experience

The primary personnel responsible for electrical design (hereafter referred to as the 'lead electrical designer') must have at least 10 years post graduate experience working in Australia and must provide rigorous quality control of the design documentation throughout the project before submitting to the Principal for review. They are required to be a PWC accredited engineer if the design includes backbone electrical infrastructure, requiring PWC approval for construction. All members of the electrical design team must have a minimum of 5 years post graduate design experience. If graduates and staff with less than 5 years of design experience are directly assigned to NTG projects, they must be closely supervised by the lead electrical designer who is directly responsible for their work.

The quality of all work submitted to the Principal is the responsibility of the consultant. This will be reflected in the Consultant Performance Scorecard and may be used as a basis of assessment for future NTG tender submissions by the consultant.

For projects with specialist requirements such as:

- Holistic approach to site security inclusive of risk assessments in accordance with ISO31000 Risk Management and HB 167 Security Risk Management Handbook, in addition to electronic security access systems and CCTV,
- Special lighting and control systems,
- Solar and battery systems,
- Fuel delivery systems,

The consultant must engage specialist experts to assist in the design of such systems, or otherwise provide evidence of their competence and familiarity with the design of such systems in the tender submission if designing it themselves. If the consultant does not have specialist knowledge of these systems and has not made allowances for this in their tender offer, no variation to cost will be approved if the design is not approved by the Superintendent. All additional costs to engage specialists during design delivery will be borne by the consultant.

## 5 General Design Requirements

Any design aspects not specifically addressed by this minimum design standard shall be identified by the designer and brought to the attention of the Superintendent for resolution during the design process.

The design and installation of electrical services and equipment in buildings must comply with all current statutory requirements and current applicable Australian Standards.

The documentation must be quantitative, fully descriptive of all works to be undertaken, and able to be accurately quoted by contractors, with no ambiguity and no assumptions. Allow for all design considerations described in this MDS that are required for a fully functional outcome of the final product as specified in the RFT/RFQ.

The design must be based on a full site investigation undertaken by the consultant and include all existing services, including backbone infrastructure, that must be installed, changed or upgraded to accommodate the proposed new works required of the design to be functional as intended.

The design must be sustainable, with the primary design criteria of longevity and minimum maintenance cost.

It is not acceptable to indicate that services shall be designed and installed to the requirements of a particular Australian Standard. Provide installation details on drawings.

Generic statements, such as *'Information for Design Intent Only'* on drawings for tender issue, are not acceptable. The tender drawings are to be the construction drawings.

### 5.1 Design Compliance

The design and installation of electrical systems must comply with the following:

- Current applicable Australian Standards
- National Construction Code (NCC)
- Local Council requirements
- Northern Territory and/or Federal requirements
- Power and Water Corporation requirements
- NT WorkSafe Health and Safety requirements
- NT Police, Fire and Emergency Services
- Environment Protection Authority requirements
- Work Health and Safety (National Uniform Legislation) Act 2011 and its Regulations
- Relevant Work Health and Safety Codes of Practice
- The Department's Standard Specification for Environmental Management, available via <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-specifications/environmental-management>
- NTG Technical Drawings Part 3 - Documentation Manual for Buildings, available via [https://dipl.nt.gov.au/data/assets/pdf\\_file/0017/1030391/ntg-technical-drawings-part-3-documentation-manual-for-buildings.pdf](https://dipl.nt.gov.au/data/assets/pdf_file/0017/1030391/ntg-technical-drawings-part-3-documentation-manual-for-buildings.pdf)
- All relevant work sections of the Department's Master Specification for Major Building Works. Copies of these work sections must be requested through the DLI Project Manager
- The Department's Solar Power Design Brief and Layout Criteria. A copy of this must be requested through the DLI Project Manager
- The Department's typical vapour barrier details and vapour barrier specification, available via <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-specifications/buildings> .
- Department of Corporate and Digital Development (DCDD) - Data and voice cabling standards - Latest Version, available via <https://dcdd.nt.gov.au/office-of-digital-government/ict-policies-standards-procedures>
- Recommendations and directions of the building certifier
- The requirements of other authorities or entities with jurisdiction over the works
- Any other relevant Acts, Regulations, Standards, Codes, and Guides.

Where there are any conflicting clauses between any of these authorities, standards and regulations, then the more onerous, and/or the higher quality, and/or the higher standard, and/or the more comprehensive requirement takes precedence.

## 5.2 Energy Considerations

Design for minimum energy consumption. The Sustainability Minimum Design Standard requires compliance with NCC 2022 Section J for buildings that are above the DLI Section J Compliance Threshold. For electrical services, compliance with NCC 2022 Part J7 is required for *all* buildings (without qualification). Consider the following in the design:

- NCC 2022 Part J7 compliance is required for all buildings
- Dual technology occupancy sensors to meet client and NCC 2022 requirements
- High efficiency LED luminaires
- Use of LED Emergency and Exit lights
- Solar panels in conjunction with PWC supply
- Power factor correction
- NCC 2022 Section J9 energy monitoring

Where specific measures are taken to reduce energy consumption, provide lifecycle costing of that design.

**Note :** For the purposes of this design standard the provisions of Section J in the Northern Territory Appendix in Schedule 6 of the NCC 2022 Volume 1, do not apply. Use the provisions in Section J in the main body text of the NCC 2022 Volume 1.

## 5.3 Design on Existing Buildings

For designs associated with existing assets, the consultant must attend site and determine the existing site infrastructure for all electrical services i.e. power (including UPS and generators where applicable), ICT, fire detection, electronic security and monitoring, including, but not limited to:

- All existing ceiling services in the area of works or otherwise noted in the specific scope of works
- Available above-ceiling space for services for all cable access
- Switchboard capacity, ICT cabinets and any control panels including FIPs, PA and any MATV systems
- Existing specialist equipment
- All existing services and outlets in the area of works or as specified in the specific scope of works
- Power and ICT cable and fibre reticulation through overhead and underground network throughout the site that will be, or has the potential to be affected as a result of the works

For designs associated with existing assets requiring additional electrical loading. The consultant must, in addition to the above, include the following as part of the existing site investigation:

- Data logging of all relevant distribution boards and switchboards to determine existing maximum demand and electrical capacity
- Physical investigation of all overhead and underground electrical and ICT cable reticulation within the site, up to the point of supply into the lot, that will be, or has the potential to be affected as a result of the works

Following the outcome of the investigation, the consultant must fully design and document the exact scope of works on all existing site services required to meet the functional design requirements. Provide photographic detail where appropriate. Photos of cabinets and boards are to be shown with doors open to show available capacity, condition, and ease of identification of existing circuits by the construction tenderer for quoting purposes.

If attending site before submission of a fee offer is not possible, the design consultant will make all necessary allowances required to inspect all services required to meet the minimum design standards set out in this document.

### Data Logging Requirements

The requirements for the data from logging is set out below:

- If undertaking own logging, the data must be logged for a week at minimum, during a period when typical peak demand can be expected. Inform and negotiate with the Superintendent regarding optimal logging time periods if low peak periods are expected during the design period e.g. school holidays.
- Data to be logged must be time stamped, be at maximum of 15 minute intervals, containing the 3-phase (or single phase if on a single phase system) voltage, current, power (real, apparent and reactive) and power factor.
- For logging data required from utility smart-meters, the consultant must pay for the local utility to provide the latest yearly electrical meter data. The consultant must have already identified and note the relevant PWC meters and meter numbers during their site investigation. It must be of the past year from the date of access of the data by the utility, or from the date of submission and payment of the data request, whichever is later.

All meter data obtained must also be sent to DLI Electrical Services, through the Superintendent. The data provided must be in a format such that the data is readily accessible via freely available, or common, widely used, software. Data in a proprietary format, specific to a single logging equipment company's software is not acceptable.

## 5.4 Design Development Stages

The consultant shall fully design to meet these minimum design standards for electrical services. Where the design stages below differ to the design stages of the project specific scope, the deliverables outlined below must still be submitted for review at the appropriate submission phase in the delivery stage from the respective scope of works.

The stages described below detail the minimum expected deliverables at each stage for client review. Approval must be obtained by the Superintendent to proceed to the next design stage.

### 5.4.1 Site Investigation

The design consultant is required to familiarise themselves with the locality of the site via full site investigation. This includes taking photos, stakeholder consultation and coordination with the Superintendent. For sites with existing infrastructure, refer to section 4.3. Failure to allow for the requirements under section 4.3 in the consultant's fee offer does not absolve the consultant of their responsibility to meet this section of the MDS, nor will a cost variation be approved by the Superintendent during the design.

### 5.4.2 First Submission (25% Design)

- Written return brief to DLI for verification and acceptance that the design concept is understood and will be adhered to by the consultant. Submissions and correspondence made to authorities are to be included with any correspondence as an appendix.
- Site layout with proposed location and indicative sizes of plant rooms, generator room, switch room, communications and security room.
- **For existing sites only:** Identified existing services that will be directly or indirectly impacted by the works to be documented on drawings.
- Photos of site to be shown at minimum:
  - Images of existing main switchboards, distribution boards, and communications cabinets are to be shown open, including showing all ELV services and available capacity.
  - General locations of proposed main and sub-main cable reticulation including all existing overhead cables along ceilings and indicative underground pit and pipe network.
- Locations of substations and ring main units (where applicable) to be identified.

### 5.4.3 Second Submission (50% Design)

- Updated drawings from the previous stage with any feedback fully addressed
- Building layout must be finalised or close with only minor adjustments required. Floor space allocated for services infrastructure must comply with all relevant standards and be confirmed as acceptable by the Superintendent and end-user.
- Photos must be provided on the design drawings to aid the building contractor in understanding existing site conditions when pricing the works based on the design.
- Layout plans with detailed services must be provided and include at minimum:
  - Existing and proposed power and communications fibre interconnections including connection point into the lot if new service to site. Also include proposed pit and pipe network reticulation including modifications to existing
  - Existing general power and lighting including distribution board locations
  - New/proposed general power and lighting
  - Exit and emergency lights
  - Proposed cable ladder and basket reticulation
  - Indicative maximum demand
  - Single line diagram with indicative cable sizes and number of pole/circuit breaker spaces including spares. If works are on existing board, the SLD must clearly show the proposed changes/upgrades
  - Proposed access control and CCTV locations (if deemed a requirement in the scope of works). Control gear and stations must be shown on floor layout
  - New and existing ICT equipment locations and data points
  - Fire detection and FIP locations
  - Hearing augmentation (where determined to be a requirement by the building certifier)
- Where network upgrades are required, PWC design drawings that have been or will be submitted to PWC for review

#### 5.4.4 Third Submission (75% Design)

- All detail from the previous design submissions incorporating previous design feedback
- Further detailed building service layout plans including demolition and all switching methods/controls of lighting circuits and all circuit identification
- All services outlets and wall mounted services equipment to be shown on internal and external architectural elevations
- Detailed connection schematics of proposed systems:
  - Communications cabinets fibre interconnections including connection point into the lot if new service to site. Also include pit and pipe network i.e. conduit and pit types and sizes
  - Electrical single line diagram showing all connections to existing or new network, maximum demand and volt drop calculations
  - Hearing augmentation system
  - Generator details inclusive of room air flows calculations and fuel system
  - Any other electronic system specific to the project must be detailed at this stage
- Draft submission of project specific updates to the construction tender specification document
- Draft safety in design report

#### 5.4.5 Fourth Submission (95% Design)

- Full set of complete design drawings incorporating all comments from previous designs stages
  - Exact locations of outlets on architectural elevations to be finalised and checked to be matching with electrical services drawings before submitting to Superintendent
- All design details and schematics must be clear and finalised
- Maximum demand calculations to be finalised
- Complete safety in design report
- Updated construction tender specification

#### 5.4.6 Final Submission (100% Design)

- Complete set of design drawings incorporating all previous design stage comments ready for construction
- Complete construction tender specification
- Complete safety in design report
- Approved PWC drawings ready for construction (where applicable)

On completion of design works, along with all required documentation for tender, submit all CAD files, supporting calculation reports, program data files and safety in design (SID) reports.

## 5.5 Co-ordination of Electrical Design

The consultant must liaise and co-ordinate with all authorities (where applicable) and disciplines on the project including but not limited to the following:

- Power and Water Corporation (PWC)
- Department of Corporate and Digital Development - responsible for all NTG ICT and liaison with NBN Co, Vocus, and other internet service providers
- NT Police, Fire and Emergency Services
- Architectural
- Mechanical
- Civil
- Structural
- Hydraulics
- Landscaping

Ensure nominated building services elements e.g. mechanical duct, plant, services switchboards locations and clearances, cable tray/ladder, etc. and their locations are consistent across all discipline documentation and do not conflict. The consultant will rectify any conflicting information at their own expense.

### Consultant must co-ordinate and verify design and specification of systems

Co-ordinate with all disciplines to ensure the sufficient provision of power (including backup power) and data to the required services and systems of all applicable disciplines. The consultant, including all design disciplines, must agree and confirm that the functionality of the designed and specified systems have been proven and can be practically installed and commissioned by a contractor.

Any design requiring Building Management Systems for the control of all mechanical, electrical and hydraulic services will have their details fully documented on the mechanical drawings. The consultant must co-ordinate designs across mechanical, electrical, and hydraulic services controlled by the Building Management System e.g. metering and monitoring.

## 5.6 Seismic Restraint

Seismic restraint to AS 1170.4.

The consultant must co-ordinate with a certifying structural engineer, the design of seismic restraints of all building services elements, for all services disciplines i.e. electrical, mechanical and hydraulic, to ensure the requirements of AS 1170.4 are met.

## 5.7 Space for Equipment and for Maintenance Access

The consultant must ensure sufficient clearances have been allowed for the installation and maintenance of all the electrical services infrastructure including, but not limited to, communications racks, distribution boards, mechanical services control panels, etc. All switchboard and distribution board clearances must comply with AS/NZS 3000. All communications cabinet clearances must comply with the NTG Data and Voice Cabling Standards, accessible via <https://dcdd.nt.gov.au/office-of-digital-government/ict-policies-standards-procedures>.

The consultant must verify physical space allocations and mandatory clearances of nominated equipment including, but not limited to:

- All services cabinets, and UPS systems
- Switchboards and distribution boards
- Mechanical services control panels
- Nurse call equipment
- Fire indicator panels
- Emergency lighting monitoring equipment
- Fixtures
- Plant
- Future installation of extra circuits and additional equipment on switchboards and distribution boards
- Clearances for routine servicing, maintenance, and repairs to the above items

### 5.8 Technical Specification

The consultant must update the relevant electrical work sections in the Master Specification for Major Building Works to make it project specific and form the construction specification for the building tender. The template master specifications work sections for Major Building Works are available via the Superintendent for the contract.

The Specification must be used where necessary to clarify the design intent and to convey technical requirements which are not appropriate or not suitable to be included on the drawings.

### 5.9 Designer Submissions – Plant and Equipment Schedules

Provide schedules for all proposed items of plant and equipment.

At minimum, the Design Drawings must include the following information in a table of the nominated equipment:

- Make
- Model name, designation, and number
- Size, including required clearances for installation
- Capacity of all system elements
- Performance characteristics related to all inputs, all outputs, and all the functions of the item
- Proposed location or reference onto the layout drawings
- Certification of conformance to the applicable code or standard
- Assumptions and comments by the consultant

For each item nominated, the following technical information must be provided to the Superintendent:

- Technical data sheets
- Energy efficiency characteristics of proposed item and/or system
- Country of origin and manufacture
- Materials used in the construction
- Certification of conformance to the applicable code or standard
- Calculations and information charts and graphs
- Manufacturers' technical literature
- Type-test reports
- Other information listed in this Minimum Design Standard as being required

Specification by brand name and catalogue number is acceptable, however, the document must clearly state that equivalent alternatives may be offered for the Superintendent's consideration.



Ensure that the specified equipment, fixtures, fittings, cables, conduits etc. are suitable for the intended location within the NT, and that serviceability and spare parts are readily available in Australia at minimum. Preference must be given to products readily serviceable by local contractors in the NT.

### 5.10 Electrical Services Minimum Capacities and Guarantees

All electrical services must be designed such that the installed systems and electrical building assets are:

- Reliable;
- Easy to maintain and repair;
- Energy efficient and incorporating sustainable design initiatives; and
- Optimised for minimum life cycle cost over a 25 year life cycle.

### 5.11 Environmental Conditions

Obtain data from an Australian Bureau of Meteorology source applicable to the project location and insert the applicable details where the prompts *[enter value]* appear below, and provide this information in the technical specification (refer section 5.8 of this document).

Consultants must make themselves aware of the climatic conditions prevailing in the area of the project, especially, but not limited to, severe wind conditions, extreme rainfall events, lightning strikes, flooding, fires, smoke, dust, humidity levels, temperature ranges, and levels of irradiation from the sun.

Temperature range: *[enter value]* °C to + *[enter value]* °C

Isokeraunic/Isoceraunic Level: *[enter value]* days (Refer to "Lightning Protection" below.)

Humidity: *[enter value]* %

The area may be subject to high levels of windborne dust during dry periods. Drifting smoke from fires in the adjacent regions must be considered.

### 5.12 Design Drawings

General requirements for drawings:

- Comply with the NTG Technical Records – Part 1 and NTG Technical Drawings - Part 3  
Web link: <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-records>
- The floor plans, drawings and text, must be legible when reproduced at A3 size. The scale bar must be legible when reproduced at A3 size. Plans generally to be at 1:100 scale when printed unless a different scale is specified.
  - If A1 drawings must be produced for any reason, the text on the drawing must be sized to Table 1 in NTG Technical Drawings – Part 3.

Drawings may be produced in colour under the following conditions:

- Building and services elements plotted in colour used on plans, sections, elevations and details must be easily distinguishable when plotted from AutoCAD/Revit in black and white, or when printed from PDF in greyscale.
- The colours used must not result in large areas of black/dark grey when plotted in black and white/greyscale.
- The instruction to print drawings in colour must not be applied to compulsory to read drawings.
- Diagrammatic illustrations (such as 3D isometric views) and photos are exempt from colour restrictions.

As a minimum, drawings must include, but not be limited to the following, as applicable to the design project:

- Site plans showing the location of the works and cable reticulation on the layouts
- HV single line diagram of the relevant portions of the PWC HV system putting the works in the context of the network (where electrical network upgrades are deemed a requirement);
- LV detailed single line diagrams including but not limited to:
  - LV circuits corresponding to all circuit groups shown on layout drawings
  - Cable sizes
  - Voltage drop
  - Protection ratings
  - Circuit breaker type
- Control topology / network drawings;
- Single line diagrams of all ancillary supplies, such as DC systems;
- Details of earthing systems, including layout drawings, schematic drawings and cable sizes. All bonding to be shown on drawings
- Protection Reports and protection coordination
- Layout drawings showing building and all major equipment locations, including distribution and switchboards. Dimensions are not required on the electrical drawings except for coordination purposes.

Refer to Appendix A of this document for “Minimum Standard Single Line Diagram”.

The Drawings and Specifications must clearly indicate the Scope of Works and must provide details of all the components to be installed. Specification by brand name is acceptable.

The Architectural Design Drawings (internal and external elevations) must include the locations of all the electrical accessories e.g. switches, socket outlets, light fittings, air conditioning controls, access and security keypads and cards readers, door lock override pushbuttons, etc. including mounting heights and critical dimensions. Electrical drawings must accurately reflect the electrical equipment shown on the room layout sheets and locations.

Provide individual floor plans for each building. No typical drawings for floor plans will be accepted.

## 5.13 Scope of Deliverables

### 5.13.1 General

Provide the electrical services design documentation consistent with the following descriptions. Unless directed by DLI, the following shall constitute the minimum required details to be described in the design submissions:

- Electrical Services Detailed Design Drawings
- Technical Data
- Control Functional Descriptions
- Calculations

### 5.13.2 Preliminary details

Submit preliminary concept documentation for review indicating the design, construction, commissioning, and maintenance characteristics of the works intended to meet the objectives of the project scope of works.

If the design is on an existing NTG asset, the documentation must include all the existing services within the affected area of works at minimum, with details showing modifications to these services e.g. demolition or relocation of affected services.

If DLI provides feedback that the proposed design is considered inconsistent with the objectives of the specification, the consultant must amend and resubmit the design.

### 5.13.3 Workshopping

When requested by the Superintendent, convene a workshop to resolve any issues, queries, concerns, or conflicts.

### 5.13.4 CAD Drawing Requirements

All Electrical CAD Drawings are to conform to:

- NTG Technical Records – Part 1 – Requirements for Technical Records Management
- NTG Technical Records – Part 3 – Documentation Manual for Buildings

Available via <https://dipl.nt.gov.au/industry/technical-standards-guidelines-and-specifications/technical-records>

### 5.13.5 Design and Construct – Preliminary Submissions and As-Constructed Submissions

Conform to the requirements in this document and the requirements in the Master Specification for Major Building Works. As-Constructed CAD Drawings must comply with the CAD Drawing Requirements. Conform to the requirements of the Building Certification clauses in the Request for Tender/Request for Quotation for the project.

### 5.13.6 Calculations

Submit calculations upon request by the Superintendent. Such calculations may be requested to verify consistency and compliance with any relevant standard, code or regulation

### 5.13.7 Certification

Submit certification upon request by the Superintendent, as evidence that the proposed equipment meets the statutory and design requirements of the contract documents.

## 6 General Power

### 6.1 General Electrical Services

Provide the design calculations for maximum demand, voltage drop, fault levels, cable sizing and fault loop impedances, including 30% redundancy allowance.

Determine all the circuit breaker sizes and protection settings. Ensure selectivity between circuit breakers, including 30% redundancy allowance.

Generally allow to run cables on cable trays above the ceiling of the corridors and public access areas. Size trays and their suspension systems to facilitate the installation of 30% additional cable during the design life of the building and whilst the building is in full use.

In smaller buildings, stainless steel or coated galvanised catenary wiring may be utilised for cable support. Provide minimum 100mm segregation between LV and ELV services run in parallel and 50 mm at crossovers.

Design the cable locations in the walls to the specific requirements of AS/NZS 3000. Ensure all conduits external to the building have a minimum of 50% spare capacity.

Seal all enclosures, including Distribution boards, junction boxes, and cabling racks, against the entry of vermin.

Seal all conduit ends to prevent the entry vermin. Seal all external luminaires against entry of insects.

Seal all building penetrations against wind driven rain, vermin and insects.

Where cables pass from an air-conditioned space in to an unconditioned space, seal the penetration against ingress of water vapour. Vapour barrier to be continuous.

Sealant must be fire rated if through a fire rated wall.

Electrical floor plans must have circuit identification relevant to the switchboard single line drawings.

No proprietary equipment or programs to be nominated for BMS, fire security, generation, or mechanical control systems.

Lighting and GPO circuit loads must not exceed 75% of circuit breaker capacity.

Outlets to be Clipsal Pro Series or a DLI approved equivalent

Provide nylon jacket for all underground mains and sub-mains cables.

Nominate hydrovacating to expose any existing underground services.

All excavations through roadways not in a road reserve and carparks to be backfilled with stabilized sand, and all bitumen repairs to be compacted hotmix/asphalt, to the Civil Works work section of the Master Specification for Major Building Works.

Routing of services under roadways in road reserves must be via thrust boring.

Minimum of 300mm clearance between cable support systems and ceiling grid.

## 6.2 Incoming Site Supply

**Note: The Electrical Design Consultant must be a PWC accredited engineer.**

Where backbone supply upgrades are required, co-ordinate with all relevant authorities to ensure the sufficient provision of power and data to site. All new supplies or upgrade to supplies must be documented and submitted for approval to the satisfaction of the relevant authority, with written approval for construction.

Power and Water Corporation are the utility authority responsible for the supply of power and water to site. The consultant is require to liaise and coordinate with PWC, and obtain the authority approved designs to enable supply to site, ready for construction tender.

The NTG Project Management Office for ICT Services (NTG ICT) is responsible for liaising and coordinating with the service provider to enable communications infrastructure to site. The consultant is responsible for coordinating with NTG ICT to design all works within the site i.e. pit and pipe network changes, upgrades and new works, including fibre runs *within* the lot. The consultant is responsible for designing all the fibre runs from the service provider connection point into the lot, to the main comms rack and all downstream fibre runs.

## 6.3 Main Switchboard Room

Provide an environment controlled system to ensure the room temperature does not exceed 27 degrees Celsius.

Co-ordinate and liaise with the building designers to ensure enough space is allowed in the building design to enable delivery and installation of the electrical related components, and to provide sufficient circulation space for servicing and maintenance activities and for the personnel and their equipment.

The doors of the main switchboard room must be sized appropriately to accommodate switchboard size for installation and removal. At minimum a 2.4m high double door for large boards or 2.4m & 1m single door shall be allowed for smaller boards. Safe installation methods and craning of equipment into switchrooms must be considered for all external access. Large switchboards may be installed in 2 sections and reconnected by the switchboard manufacturer and retested for safety of installation.

Space in the main switchboard room to be allowed for a static VAR power factor correction unit.

All clearances in the switchroom must be to AS/NZS 3000

## 6.4 Switchboards

**No custom made enclosures are allowed without the approval of the Superintendent.**

Boards must be full metal boards (stainless steel when near marine environments) with lockable doors and hinged escutcheons.

Ensure that there are a minimum of 30% spare poles in each Board.

All boards must to be Form 3b or 4a if rated at 800A or greater.

RCD protection must be by individual, single pole width RCD/MCBs.

For proprietary distribution boards, type tested modular enclosures must be used.

Determine, and indicate on drawings, circuit breaker type for fault loop impedance satisfaction - electronic or magnetic.

All switchboards to meet the requirements of AS/NZS 61439.1:2016, AS 1627.4:2005 and all other relevant standards.

All Legends must be supplied typed and laminated.

Provide a single line diagram for each switchboard inclusive of circuit identification, all cable sizes, calculated maximum demand and fault rating, form rating and surge protection. Include within design sufficient room for cable terminations.

For all switchboards 800A or greater, include space in design and label drawings for solar and PFC circuit breakers and CTs. Design process must consider type of static VAR generation to be installed if found to be required. Power monitor units to be installed using the same CTs for PFC requirements with a safe termination space in the MSB for all control cabling terminations. Cable terminations for CTs/VTs, controllers and other equipment within the same compartment as busbars will not be accepted.

Cable terminations must lugged and bolted to circuit breakers rated at 100A or more. Tunnel terminals will not be accepted.

## 6.5 Cabling

Only copper conductors are permitted complete with nylon jacket termite protection for all mains and sub-main cabling in underground conduits. Flexible cables are the preferred cable type for larger main sizes.

Provide 30% redundancy when sizing cables and conduits.

Voltage drop to be shown on drawing single line diagrams or shown in a separate schedule on the drawings

All earths must be sized to suit earth fault loop impedance.

## 6.6 Conduits

Ensure that conduits carrying multiple circuits are sized with 30% redundancy.

Long runs of dedicated conduits shall be appropriately sized to reduce the risk of damaging the cables during installation.

All exposed electrical cabling must be protected by running the cabling through conduit.

Exposed means not covered on all sides by linings and/or structural members.

Protection means physical protection of the cabling and associated fittings, and protection against vermin gaining access to the interior of the conduit, and to any associated fittings.

If there is any possibility of the cabling and conduit being subject to physical damage and/or mechanical damage. The conduit used must be of galvanised steel.

Cabling must be mechanically protected at 2000mm and below it does not have to be galvanised steel conduit if not deemed a high risk.

All electric cabling installed outside a building is to be treated as being at risk of physical and/or mechanical damage.

### UV Exposed Conduits

If PVC conduit is suitable for use, the conduit must be grey UV stabilised PVC. Grey solid manufactured conduit must be maintained throughout the entire length of the cable run. Use of manufactured conduit fittings or bending spring for sets and bends must be prioritised before use of any flexible conduit. If flexible conduit must be used, it must be Anaconda or equivalent and approved by the superintendent. In the case of pole top installations where flexible conduit is required, it must be Anaconda or equivalent; corrugated conduit will not be accepted.

## 6.7 Maximum Demand

Maximum demand calculations must be undertaken as part of design. Electrical equipment and switchgear is to be sized appropriately with the maximum demand as the basis for selection. Update the maximum demand calculations as necessary during the design process. Allow 30% redundancy for whole of site, unless otherwise directed by DLI. Calculated maximum demand must be shown on single line drawings. Show the maximum demand and additional 30% redundancy separately.

## 6.8 Power Factor Correction (PFC)

All PFC units must be static VAr generators. Alternate technologies for power factor correction must be approved by the superintendent.

For existing sites, a load profile must be recorded to determine the required PFC arrangement and determination of PFC unit size (kVAr).

Design to meet Power and Water Corporation (PWC) Network Technical Code power quality requirements. This includes reviewing the impact of new equipment installations on existing buildings' power quality (eg. power factor and harmonics).

Target minimum power factors at the peak load of each calendar month are:

- For buildings forecast to use under 750 MWh per annum (that do not have a peak demand kVA component in their tariff): between 0.9 lagging to 0.9 leading as per PWC Network Technical Code requirements
- For other buildings: between 0.98 lagging to 0.98 leading

New building construction Requests for Tender must include a provisional sum for installation of Power Factor Correction equipment to be estimated by the designer and included in documentation.

Designs must include:

- A designated space, and a Main Switch Board circuit breaker, for Power Factor Correction equipment in the environmentally controlled main switchboard room.
- A note on drawings:
  - Stating the target power factor
  - A note with a requirement for post construction measurement of power factor at peak load conditions over a 6-month period; and
  - Installation of static VAr generators if power factor rectification is required

## 6.9 Lightning and Surge Protection

Provide calculations and lightning protection proposal (if required under SID report), incorporating a Faraday cage configuration with roof/tower mounted finials (lightning rods) compliant with AS/NZS 1768 appropriate for the Isokeraunic/Isoceraunic levels of the site. The preliminary design proposal must be submitted and approval by the Superintendent prior to inclusion in the final design. Include surge diverters and other lightning protection measures on the internal electrical infrastructure.

Main switchboards must have 200kA and distribution boards to have 100kA surge protection devices respectively. Surge protection devices selected must have clearly distinguishable fail indicators that can be seen without removing covers and exposing other live components.

Dynasphere system may be accepted as an alternative if approved by the client, consultant must present the benefits of the alternative system to the superintendent for consideration.

## 6.10 Metering

The electrical design must include provision of meters to cover:

- Incoming check meter(s)
- Artificial lighting
- Appliance power
- Lifts and other internal transport devices
- Diesel generator electricity production
- Solar PV electricity generation

Where the installation incorporates a new or existing BMS system, connect the meters into the BMS system to facilitate the monitoring of the magnitude and pattern of energy consumption

For all buildings, the electrical design shall include provision of electronic "smart" meters in each Distribution Board.

Electrical design documentation shall include documentation of the metering systems provided under the scope of the electrical design and shall be coordinated with the mechanical design to ensure a consistent approach to metering documentation with a consistent naming convention.

Generally for all designs, the requirements of NCC 2022 Part J9 shall apply. The lead responsibility for the metering system shall be under the mechanical design. The electrical design shall be coordinated with the mechanical design to ensure the following requirements are met using standardised BACnet or BACnet over IP compatible equipment.

Minimum metering requirements are:

<b>Table - Minimum Design Standard – Electrical Services – Minimum metering requirements</b>	
Incomer check meters	15 minute (minimum) interval data, meter specifications equivalent to Power and Water Corporation smart billing meter requirements (at minimum, must record kWh, kVA, kW, kVAr and power factor and retain data for at least 12 months)
Sub-system meters	15 minute (minimum) data kWh or MJ, smart meter (same specification as incomer check meters preferred)

For buildings that require a sub-metering system under NCC 2022 J9D3 *Facilities for energy monitoring (2)*, and for any building with a central plant HVAC configuration, the sub-metering system must have remote access capability and independently capture the following end use categories:

- Incomer check meter(s)
- Chillers
- Chilled water plant ancillaries (i.e. pumps and cooling towers)
- Heating hot water generators
- Heating hot water system pumps and ancillary loads
- Fan coil units and air handler fans
- Artificial lighting
- Appliance power
- Central hot water supply (domestic)
- Lifts and other internal transport devices
- Diesel generator electricity production
- Solar PV electricity generation
- Other ancillary plant

Note that metering requirements for the above categories are to be understood as a requirement to capture the aggregate of all units within the category. It is not the intention to individual sub-meter each individual unit in each category.

## 6.11 Earthing

To be designed to meet AS/NZS 3000 Section 5.

Wet areas to have reinforcement steel bonded and earthed.

Cables trays, permanently installed steel structures and framing to be bonded and earthed. Equipotential earthing must be maintained on all cable tray/ladder runs, particularly where there are breaks between sections of trays.

Earthing cables to be sized appropriately and fault levels are to be provided to DLI.



## 7 Lighting

Provide a schedule of any specific lamps to be used. Luminaires which require specific lamps shall be permanently labelled on a surface, clearly visible to the Maintenance Personnel, indicating specific lamp requirements and the lamp description.

If requested by the Superintendent, provide copies of all lighting calculations and isolux diagrams for all artificially illuminated areas, both internal and external to the building. LED light fittings are preferred over discharge light fittings on all external lighting including carpark lighting, area lighting, and high use sporting arenas.

All lighting designs shall comply with the maximum illumination power density limits prescribed in NCC 2022 Part J7D3.

Artificial lighting systems shall be designed to achieve the minimum illuminance levels specified in AS/NZS 1680 and must not exceed the minimum illuminance requirement by more than 20% at Project Completion (except where it can be demonstrated that lamp depreciation requires a greater initial illuminance to ensure sufficient illuminance at the end of lamp life).

Lighting design documentation is to be provided verifying that the following AS/NZS 1680 glare index and uniformity requirements are met as evidenced by inclusion of a table on drawings detailing the classification categories used for different areas.

Provide the maintenance factors and lamp depreciation factors used in the calculations.

When selecting suitable light fittings the following needs to be considered: fit for purpose, whole of life, value for money, and replacements must be readily available.

Internal LED fittings to be a minimum low glare L80 50,000 hour life expectancy and minimum luminaire efficacy of 100 lm/W.

All fittings to be plug type. Lighting sockets to be hard wired with looping terminal. Piercing type connectors are not acceptable.

Dual technology occupancy sensors to be utilised for all hands-free light switching.

Lighting control shall be compliant with NCC 2022 Part J7D3 and lighting control devices shall be compliant with NCC 2022 Specification 40, with the following clarifications and additions:

- Dual technology motion sensors shall be employed wherever automated control is required (specific exceptions will be considered by DLI where the designer can provide a justification for an alternative control device)
- Irrespective of building/storey size, automated lighting controls shall be employed for all intermittently occupied spaces such as bathrooms, meeting rooms, break-out spaces, classrooms, lift lobbies, thoroughfares etc.
- Motion sensor controls in sensor-integrated luminaires shall be provided for all underground and/or undercover car parks with the capability for auto-dimming to a standby illuminance level. The designer shall undertake a risk assessment to determine a safe standby illuminance level for the specific application.
- Fire-stair lighting control must comply with NCC 2022 Part J7D4 (6) and Specification 40. The preferred best-practice option for doing so is with sensor-integrated luminaires with internal controls for auto-dimming to a standby illuminance level. If electing not to employ this technology the designer shall provide justification to DLI for approval prior to final design.

Design documentation to include a lighting controls functional description, schematics and product list for review and approval by DLI. The lighting controls functional description shall document the lighting control infrastructure and control strategies (both manual and automatic) to be employed in each type of space, in sufficient detail so that functional tests can be performed using the description as a reference for intended outcomes.

## 7.1 Exit and Emergency Lighting

Provide exit and emergency lighting in accordance with the requirements of the NCC 2022 and AS/NZS 2293.

Consider providing additional emergency lighting in critical areas (to assist the facility occupiers/users during any period of loss of normal power supply).

Zoneworks monitoring to be utilised for larger sites where emergency lighting and exit signs maintenance testing can be expected to be time intensive.

## 8 Data and Communications

Communications requirements to be in conformance with:

- All relevant Australian Standards
- Latest version of NT Government Data and Voice Cabling Standard (available at <https://dcdd.nt.gov.au/office-of-digital-government/ict-policies-standards-procedures>)

CAT 6A U/FTP is the standard requirement for all NTG building assets

On Department of Education (DoE) projects, comply with the latest NTG DoE ICT requirements for schools.

The number of lead-in conduits into the site/lot must be considered at design stage to provide access for NBN and multiple providers. The quantity will be determined in consultation with the NTG Project Management Office who will advise on the specific requirements.

Outlets to be Clipsal Pro Series or a DLI approved equivalent – deep wall boxes are required for termination of all data outlets and power outlets containing USB charging ports.

Correspondence with NBN Co. and other service providers, and development of plans for the installation of ICT fibre to lot will be undertaken by NTG Project Management Office. The consultant is still required to undertake all design of pit and pipe network within the lot from the fibre access point.

### 8.1 Lift/Elevator Communications

All lift/elevator phones to be connected wirelessly via a generic 3g Wi-Fi. Lift/elevator phones to be provided with a minimum 8 hour battery back-up. SIM cards for the phones will be provided by the client.

### 8.2 Software Ownership and Access

#### General

It is a fundamental requirement of the project that all controls and associated software systems are provided without any restrictions to cause the Department to be committed to specific manufacturers or controls system integrators / suppliers. All passwords and access rights / responsibilities, inclusive of access / change rights to the base controls programming, shall be passed in full to the Department prior to completion of the project.

#### Ownership

All ownership of access accounts, passwords, programming logic used, and intellectual property in the control system, must be transferred to the Northern Territory Government. All licenses for proprietary software used in conjunction with the development and/or operation of the control system must be transferrable to the Northern Territory Government.

At the date of practical completion, transfer ownership of all software, all licences, and all supporting documentation produced under this contract to the Superintendent.

### **Rights to Modify**

Assign to the Superintendent unrestricted rights to employ any person or organisation to operate, modify or replace the software. Include in these rights all login details, software and documentation (e.g. development and testing packages) necessary to achieve this.

### **Software Upgrades**

Supply and install all software upgrades, revisions, and the like, issued by the manufacturers up to the end of the Defects Liability Period.

## **9 Electronic Access Control and Security**

This clause applies to projects with security requirements of any security system incorporating swipe cards, external CCTV and intercom.

An electronic security system is to be provided to include detection via external door status monitoring and access control. An intruder detection system is to comprise the installation of door status monitoring reed switches which are to be provided on all non-public external doors in conjunction with internal dual technology intruder detectors. Electric door locking and access control (proximity card readers) are required to the external non-public entry doors and to internal doors requiring secure access.

CCTV cameras must be provided to monitor the external perimeters of all the buildings. Provide fibre optic LAN network with FIBOTS switches. Provide local power supply including 50% redundancy in each building, with surge protection, in racks. Main building to have a secure rack with server based NVR and switch equipment. CCTV equipment to be Avigilon and Access Control to be Inner Range Integrity or similar and approved by the Superintendent.

Intercom interconnections shall be as nominated on the room data sheets

### **Existing Systems**

Include in design scope/notes: Construction contractor required to engage relevant DLI period contractor to provide user name, password, and/or PIN, for installer use.

**UNDER NO CIRCUMSTANCE SHOULD INSTALLER/MASTER/ADMIN ACCESS BE DEFAULTED TO GAIN SYSTEM ACCESS.**

### **New and Existing Systems**

Include in design scope/notes: If new or existing system includes back to base monitoring then installer will be required to request a technician voice code through DLI Electrical Section in order to liaise with the Security Monitoring Centre (SMC). Commissioning of all monitored devices is to be confirmed by SMC.

### **New Systems**

Include in design scope/notes: INSTALLER, MASTER, ADMIN, USER, PASSWORD, PIN and LOGIN shall be provided to DLI upon completion of project.

## **10 Generator and Backup Power**

### **10.1 Emergency Power Supplies**

If required, design an Emergency Power Supply for the building in compliance with the following Standards:

- Standby Diesel Generator: To AS/NZS 3000:2018 Section 7.3 and AS/NZS 3010. The generator shall be a reputable brand with a local workshop and service provider with spare parts and service support

available 24/7. In remote areas with no local workshop, the service provider must be based in the NT and be available to service remote areas.

- Uninterruptable Power Supply (UPS): To AS 62040.

Provide the proposed design to the Superintendent for approval. Include:

- The design philosophy,
- Essential load Maximum Demand figures and a schedule of the equipment requiring Essential Supply.
- Maximum Demand figures and design calculations for the UPS together with a schedule of the equipment to be connected. Equipment to be confirmed in conjunction with the Superintendent.
- Generators 750KVA and above to be V-form construction.
- Independent fuel polishing units and pump to be provided for all tanks with capacity of 5000L or above. These shall be separate from the main pumps transferring fuel into the generator but may share common entry and return fuel lines.
- Local test switch at generator to be provided for actual load test of site and ATS function.
- DLI representative to view 4 hour load test requirements (0.5hr@50%, 1hr@75%, 1hrs@100%, 1hr@75%, 0.5hr@50%) at local Darwin or NT regional urban workshop.
- Manual transfer switch for temporary generator support to permanent essential generator supply.

Designed with an average radiator ambient temperature of 50 degrees or less for all generators rated above 200 kVA.

## 11 Fire Detection Systems

### 11.1 Fire Detection and Protection

Design fire detection and alarm systems, including occupancy warning systems, in accordance with the NCC 2022, AS 1670, and all other relevant Australian Standards. During the design process consider any/all special circumstances of the building, its structure, and its location.

Indicate on the drawings the location, type, and number of all detectors and alarm devices including concealed detectors where applicable. Fire services shall be shown on drawings independently from other services.

NTFast requirements to be included in the design documentation.

### 11.2 Fire Rated Cables

Fire rated cables shall be fixed to cable support systems with stainless steel cable ties.

Cable support systems for fire rated cables, including fixings to structural elements, shall be certified for performance in fire conditions.

Cable support systems for fire rated cables shall be fixed to fire rated structural elements. Otherwise use conduits with concrete encasement to provide the required fire rating.

## 12 Arc Fault Detection Devices

Arc Fault Detection Devices (AFDD) must be incorporated into all final sub-circuits in buildings containing accommodation areas. The designer is responsible for the specific circuit arrangement of AFDDs in the electrical schematic, to the relevant clause in AS/NZS 3000, as well as sizing the appropriate board size and type to contain this equipment. The designer may include AFDDs in other areas of buildings, and/or other types of buildings. That decision must be based on a risk assessment made by the designer. Final approval rests with the Superintendent.

## 13 Photovoltaic Systems

For projects with solar power requirements design in accordance with 'Solar Power Design Brief and Layout Criteria' in the Appendices to this design guideline for details.

## 14 Masterplan and Project Development Plans

The purpose of a masterplan is to:

- Ensure adequate infrastructure capacity is available for new and current developments for a minimum of 15 years;
- Minimise redundant or abortive works;
- Provide a framework for the planning of longer-term projects for the site.

Where future expansion of the site is anticipated, standalone electrical masterplan documentation must be provided. An electrical masterplan differs from an electrical development plan by providing a framework within which future development of electrical supply infrastructure at a site can take place.

Provide an electrical development plan that provides the development or upgrade of electrical supply infrastructure to a site.

It must provide a broad outline addressing the needs of the site in the areas of:

- Electrical supply into the site
- Electrical distribution within the site
- The requirements for standby generation
- The requirements for monitoring and control systems for the electrical systems.

As part of the master planning, in-principle design approval by Power and Water Corporation must be obtained.

## 15 APPENDIX A – Minimum Standard Single Line Diagram



## 16 APPENDIX B – Solar Power Design Brief and Layout Criteria



Department of Infrastructure, Planning and Logistics – Photovoltaic Design Brief 22 August 2019

Table - Photovoltaic Design Brief 22 August 2019		
Item	Design Criteria	Comments
<b>Solar PV System</b>		
Extreme ambient conditions including rain/hail/cyclonic and other conditions under which the solar panels are expected to operate.	-10° C to +65° C	Equipment shall be suited for full and efficient operations in Northern Territory climatic conditions. Special consideration is required for coastal areas subject to high humidity, high airborne salt levels, and cyclonic conditions.
Extreme ambient conditions for which inverter plant and string monitors are expected to operate.	-10°C to +50°C	Equipment shall be suited for full and efficient operations in Northern Territory climatic conditions. Special consideration is required for coastal areas subject to high humidity, high airborne salt levels, and cyclonic conditions.
Grid Connection	As required. Provide compliant grid protection and zero export devices	Comply with PWC Requirements as per Class 3 approvals.
Solar Panel selection	Panels selected must be current CEC approved PV modules	
Panel module efficiency	>19%	Per manufacturers'/CEC guidelines
Average Power Generation Yield at 25 Years	>86%	Per manufacturers'/CEC guidelines

Table - Photovoltaic Design Brief 22 August 2019		
Item	Design Criteria	Comments
Solar Panel Orientation	<p>North facing with a panel angle above horizontal as close as possible to:</p> <ul style="list-style-type: none"> <li>• Darwin, Nhulunbuy (Gove) 12.5°</li> <li>• Katherine 14.5°</li> <li>• Tennant Creek 19.5°</li> <li>• Alice Springs 23.5°</li> <li>• Other areas interpolated from these or as close as possible to angle of latitude of the site</li> </ul>	<p>Dimensions and available roof area to be confirmed on site and final system size determined by available roof area.</p>
Mounting Method	<ul style="list-style-type: none"> <li>• Non-penetrative preferred on low pitch roof.</li> <li>• Example: Clenergy</li> </ul>	<ul style="list-style-type: none"> <li>• Fixings are to have watertight seals if they penetrate the roof sheet.</li> <li>• Penetrative roof mounts are permissible provided they maintain the integrity of the roofing system and if they have watertight seals.</li> </ul>
Panel Monitoring	<p>Monitoring each panel and string connection to the inverter.</p>	<ul style="list-style-type: none"> <li>• Monitoring output performance of individual panels.</li> <li>• Remote monitoring to facility and to the Department.</li> <li>• Panel outage alerts.</li> </ul>
System performance monitoring	<p>Provision of system data to third party software to support educational and curriculum outcomes.</p>	<p>Monitoring solution shall be 3G/4G compatible and provide 5 minute interval data feeds.</p>

Table - Photovoltaic Design Brief 22 August 2019		
Item	Design Criteria	Comments
Mass/Area (kg/m <sup>2</sup> ) Panel Arrays	15kg/m <sup>2</sup>	<ul style="list-style-type: none"> <li>PV installer to verify roof strength requirements and structural calculations prior to commencement of PV installation.</li> <li>The mass per m<sup>2</sup> may be increased upon assessment and approval by the installer's structural Engineer/certifier.</li> <li>Calculations shall be submitted to the Department prior to ordering any materials and prior to works commencing on site.</li> </ul>
Inverters	<ul style="list-style-type: none"> <li>400V (3 Phase)</li> <li>Compliant with AS/NZS 4777</li> <li>Examples: Solar Edge, Fronius, SMA or approved equivalent as appropriate for the design.</li> </ul>	<ul style="list-style-type: none"> <li>Operating Voltage range in accordance with AS 60038 and AS/NZS 3000</li> <li>Inverters must be tested, and certified for use, in Australia.</li> <li>20 year product/parts warranty</li> </ul>
Supply Metering	Facilitate the provision of 3 Phase import/export revenue meter(s) to the Main Switchboard within each PWC Substation as required	New Type 2 PV Metering (import/export revenue meter) to be supplied and installed by a PWC accredited contractor at the project's cost. Include PWC meter replacement fees and charges within submission.
Power Systems <ul style="list-style-type: none"> <li>Harmonics</li> <li>Fault Current</li> <li>Over/Under Current</li> <li>Over/Under Voltage</li> <li>Frequency</li> <li>Zero Export</li> <li>Grid Protection</li> </ul>	Compliance with PWC requirements	Final requirements to be in accordance with PWC requirements and assessment

Table - Photovoltaic Design Brief 22 August 2019		
Item	Design Criteria	Comments
Compliance with Power and Water Corporation Utilities for Small Embedded Generation Equipment and Network Connections	<p>All equipment, including the inverter(s) must comply with:</p> <ul style="list-style-type: none"> <li>PWC specification “Technical requirements for Grid Connection of Photovoltaic Systems via Inverters”</li> <li>AS/NZS 4777 series</li> </ul>	<ul style="list-style-type: none"> <li>Required for connection to the grid.</li> <li>PWC documents available for download from PWC web site:  <a href="https://www.powerwater.com.au/developers/drawings-and-downloads">https://www.powerwater.com.au/developers/drawings-and-downloads</a> </li> </ul>
Electrical Wiring & Electrical Installation	To AS/NZS 3000, AS/NZS 3008, and AS/NZS 5033	
Power Factor	Within 0.90 (Lagging) and 0.90 (Leading)	<ul style="list-style-type: none"> <li>At times of the customer's monthly maximum demand.</li> <li>Refer to site inspection regarding existing PFC equipment at the site.</li> <li>Refer to respective PWC preliminary assessment for compliance.</li> <li>The proposed solar installation must not negatively impact the site's power factor.</li> </ul>
Surge Protection	Provide surge protection to the solar installation, solar distribution board and site main switchboard.	<ul style="list-style-type: none"> <li>Surge protection (DC/Solar) shall be equivalent to Novaris SDPV series.</li> <li>Surge protection (AC) shall be equivalent to Erico TDX-100 or Novaris SD3 within the site main switchboard.</li> <li>Surge protection (AC) shall be equivalent to Erico TDS-350 or Novaris within the Solar Distribution Board.</li> </ul>
Electromagnetic Interference	In accordance with AS 2344	Any electromagnetic interference caused by the installation or any plant / equipment connected must be less than the limits set out in AS 2344

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Item	Design Criteria	Comments
Disturbing Loads	In accordance with the limits in AS/NZS 61000	Voltage disturbance at the grid connection points for each site to be in accordance with AS/NZS 61000
Photovoltaic Orientation	PV installer to nominate orientations and pitches for PV panel arrays.	North facing with a panel angle above horizontal as close as possible to: <ul style="list-style-type: none"> <li>• Darwin, Nhulunbuy (Gove) 12.5°</li> <li>• Katherine 14.5°</li> <li>• Tennant Creek 19.5°</li> <li>• Alice Springs 23.5°</li> <li>• Other areas interpolated from these or as close as possible to angle of latitude of the site</li> </ul>
<b>Roof Platform, Access and Safety System</b>		
Roof access	<ul style="list-style-type: none"> <li>• Provide permanent safe roof access and safety attachment points</li> <li>• To be compliant with, and installed to, AS 1657</li> </ul>	Walkways to provide access to all panels for cleaning and maintenance purposes.
Roof walkway	<ul style="list-style-type: none"> <li>• Provide permanent walkway on roof between panel rows to support future maintenance</li> <li>• To be compliant with, and installed to, AS 1657</li> </ul>	<ul style="list-style-type: none"> <li>• Non-slip walkway surface</li> <li>• Penetrative roof mounts are permissible provided they maintain the integrity of the roofing system and if they have watertight seals.</li> </ul>

Table - Photovoltaic Design Brief 22 August 2019		
Item	Design Criteria	Comments
Roof anchor points and static lines	<ul style="list-style-type: none"> <li>• Provide safety anchor points and static lines on roof</li> <li>• The system must be installed in accordance with AS/NZS 1891 and AS/NZS 5532</li> </ul>	<ul style="list-style-type: none"> <li>• For travel restraint or fall restraint as applicable</li> <li>• Penetrative roof mounts are permissible provided they maintain the integrity of the roofing system and if they have watertight seals.</li> </ul>
<b>Warranty</b>		
Photovoltaic Panels	Minimum 20 year product and production warranty	
Inverters	Minimum 20 year product warranty	
Other electrical equipment	Minimum 7 year product warranty	

## 17 APPENDIX C – General Notes for Drawings

### General Electrical Services

1. All electrical work to be carried out by a licensed electrician.
2. Drawings shall be read in conjunction with all other discipline Drawings. Refer any conflicting information, omissions or errors to the Project superintendent for resolution
3. Refer to other notes on electrical drawings
4. Coordinate with all other trades on site for location of electrical services and isolators to be provided by the electrical contractor.
5. The contractor shall allow for investigation of concealed services prior to commencing work
6. Nominate hydro-excavation to expose any existing underground services.
7. Works to comply with all relevant codes and standards including but not limited to: AS/NZS 3000, AS/NZS 3008, AS/NZS 1680, AS 2293, the *WHS (NUL) Act 2011* and its Regulations and applicable Codes of Practice, the requirements of all relevant statutory authorities, and general best practice
8. Do not set out or scale from the drawings. Confirm all measurements on site prior to undertaking works
9. Utilise existing slab openings and cable ducts where practical, conceal cabling where possible. Where cabling must be visible, install within horizontal and vertical runs of surface mounted conduit
10. Install new cable support systems (ladder trays with 30% redundancy and insulated catenary cable) as required and ensure all cables are adequately supported across their entire length, provide at minimum: 100mm segregation between LV and ELV cabling run in parallel and 50mm at crossovers. Cable support systems must have minimum 300mm clearance above ceiling tiles
11. Make good any part of existing infrastructure that is damaged as a result of these works.
12. Provide nylon jacket for all underground mains cables. Flex cables are acceptable
13. Submit technical data sheets to the superintendent for assessment of equipment selections prior to procurement of equipment. Submit shop drawings as per RFT requirements.
14. Luminaires, dimmers and all other controllers to be installed to manufacturer's specifications.
15. All light fittings to be flex and plug type. Lighting sockets to be hard wired with looping terminal. Piercing type connectors are not acceptable
16. All occupancy detectors to be dual technology
17. Outlets to be Clipsal Pro Series or a DLI approved equivalent
18. Deep wall boxes are required for termination of power outlets with USB charging and data outlets
19. Demonstrate functionality and successful operation of all systems to client and superintendent prior to handover.
20. Obtain manufacturer's warranty of luminaires after installation.
21. All new services shall be fully labelled for ease of identification.

## Minimum Design Standard - Electrical Services

22. All excavations through roadways not in a road reserve and carparks to be backfilled with stabilized sand, and all bitumen repairs to be compacted hotmix/asphalt, to the Civil Works work section of the Master Specification for Major Building Works.
23. Routing of services under roadways in road reserves must be via thrust boring.
24. Provide a digital copy of as constructed drawings including CAD files
25. Wet areas to have reinforcement steel bonded and earthed.
26. Cable trays, permanently installed steel structures and framing to be bonded and earthed. Equipotential earthing must be maintained on all cable tray/ ladder runs, particularly where there are breaks between sections of trays.
27. Communications installation is to be in accordance with current NTG data and voice cabling standards and warranted for minimum 20 years.
28. No propriety equipment or programs will be accepted unless nominated by the client,

### Generator

1. DLI to witness workshop load testing of generator before delivery to site.
2. DLI representative to view 4 hour load test requirements (0.5hr@50%, 1hr@75%, 1hrs@100%, 1hr@75%, 0.5hr@50%) at local Darwin or NT regional urban workshop.

### Penetration Sealing

1. Seal all enclosures including distribution boards, junction boxes, and cabling racks, against the entry of vermin.
2. Seal all conduit ends to prevent the entry vermin. Seal all external luminaires against entry of insects.
3. Seal all building penetrations against wind driven rain, vermin and insects.
4. Sealant must be fire rated if through a fire rated wall.

### Switchboards

1. Surge protection to be recessed on escutcheon such that the status may be viewable without exposing busbars
2. Terminations to be separated from busbar compartments. If terminations must be in the same compartment, busbars shall be fully covered by a Perspex cover to be able to safely work on terminals.