3 High Voltage System Master Plans and Project Development Plans

3.1 High Voltage System Master Planning

An electrical master plan is a stand-alone document that provides a framework within which the future development of electrical supply infrastructure at a Defence establishment can take place. It is a broad outline addressing the needs of the establishment in the areas of:

a) Electrical supply into the establishment;
b) Electrical distribution within the establishment;
c) The requirements for standby generation, and
d) The requirements for monitoring and control systems for the electrical systems.

An electrical development plan is similar to an electrical master plan but is generally specific to a project or development activity. Electrical Master Plan and Development Plan reports must carry signature approval from DEEP before they may be circulated.

3.1.1 Master Plan Policy Objectives

The objective of this policy is to provide a strategic framework within which electrical infrastructure works are implemented in a carefully considered way. The purpose of this is to:

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

3.1.2 Master Plan Concepts

The following concepts are used in master planning and development planning as discussed in the following paragraphs and shown in the typical high voltage system diagram, Figure 3.1 below
**Figure 3.1: Typical High Voltage System Arrangement**

**Base Load Centres or Zones**

Load centres or zones are groupings of load that have a similar function and geographic location. Example load centre types may include:

a) Domestic;
b) Airfield;
c) Technical; and
d) Support load types.

They form the most basic level of priority of the electrical system. For this reason, and as far as practical, the loads associated with a particular load centre are normally connected to the same HV ring main. In times of electrical supply shortage this allows HV switching to occur to shed loads of a particular type.

**Intake Switching Stations and Intake Substations (ISS)**

Intake Switching Stations and Intake Substations (ISS) form the connection point between the DNSP feeder cables and the Defence reticulations system. ISS are part of the primary distribution system. At establishments with a separate Distribution Network Service Provider (DNSP) intake station provided prior to the ISS, these are referred to as Intake Stations (IS).

**Primary Distribution**

For the purposes of convenience the electrical distribution is divided into two major components, the primary distribution and secondary distribution.
The primary distribution is that portion of the electrical network that transfers bulk electricity around the establishment. It generally consists of a series of primary nodes that are interconnected by feeder cables, to which no load is connected along their length.

The feeder cables can be either:
- Incoming feeders from the DNSP, or
- Interconnections that directly connect the primary nodes.

The primary nodes can be either:
- Primary Switching Stations – HV switchboards, such as the establishment HV switchboard, at which no voltage transformations occur; or
- Primary Substations – Substations at which a transformation occurs from a higher voltage, such as the DNSP’s sub transmission voltage, to the HV distribution voltage used at the establishment.

Secondary Distribution
The secondary distribution is that portion of the electrical network associated with conversion of the electrical supply to the final utilisation voltage (400V). It consists of the distribution substations and the ring mains that connect these to the primary nodes.

Central Emergency Power Station (CEPS)
The CEPS is a power station that is used to produce standby power for the entire establishment, or large portions of it, in the event of failure of the mains supply.

In order to distribute this power around the establishment the CEPS is often configured so that it energises the site HV distribution network. Requirements of CEPS systems are described at Chapter 27 — Central Emergency Power Station (CEPS), Central Power Station (CPS) and Central Energy Plant (CEP).

Local Emergency Generator (LEG)
A Local Emergency Generator provides standby power for a specific facility or group of facilities during a power interruption. LEGs are typically smaller than CEPS and can start and supply critical loads quicker than CEPS.

Central Energy Plant (CEP)
A CEP is a power station that can run for extended periods to offset the electrical demand of a Base. CEP installations may also supply energy in other forms, for example waste heat from gas generators being used to run absorption chillers for reticulated cooling.

Central Power Station (CPS)
The CPS is a power station that produces continuous power for the entire establishment. A CPS is typically employed in remote areas where grid connection of the establishment is not feasible.
3.1.3 Master Planning Considerations

The master plan shall be a stand-alone document that is well justified. It shall include detailed reasoning and the rationales behind each decision, including all relevant supporting documentation, to allow review by the major stakeholders.

The following is a list of key considerations and planning objectives that should be addressed as part of any master planning process.

**Incoming Supply**

**Connection Agreements**
The electrical master plan should highlight any issues that might have an impact on the connection agreement for the establishment. This includes such issues as supply tariffs or required increases in authorised demand.

**NEC Issues**
On contestable sites or sites that could become contestable, the master plan shall address compliance with National Electricity Code. Of particular interest at most sites is power factor.

**Supply Voltage**
The electrical master plan shall consider, in terms of potential cost savings and reliability, the voltage at which the establishment takes supply. Where supply is or will be available at more than one voltage, a Net Present Value (NPV) projection shall be carried out to determine overall cost-effectiveness of each voltage.

**Redundancy and Reliability Issues**
The electrical master plan must consider the reliability of the existing and proposed mains supply with particular emphasis on the frequency and duration of supply interruptions experienced.

A key aspect in the proposed supply arrangement is the degree of redundancy offered in the DNSP network. This shall be examined in terms of the vulnerability of the supply to:

a) Network events, or
b) External attack.

Supply reliability is a key input to consideration of the need for on-site emergency power generation, particularly centralised power generation.

**Loads**
The master plan shall examine the overall master plan for the establishment and any supporting documents such as precinct plans in order to establish:

a) What new facilities are being constructed and the timeframe, and
b) What existing facilities are being demolished and the timeframe;

The impact of these works on the overall establishment load over time shall be assessed with respect to:

a) The magnitude of the load over time;
b) The changing distribution of the load, and in particular the location of the load zones, over time;

In performing these projections the following methodology shall be adopted:

a) **Existing Loads:** The electrical demand applicable to an existing facility shall be determined in either of three (3) ways:
   - Actual recorded measurements for the facility from the DESN or other recognised metering device over a continuous period of twelve (12) months. (Note that data from other than the previous twelve months should be incremented at 3% p.a.).
   - Detailed evaluation of the facility loads utilising Appendix C of AS/NZS 3000; or
   - Careful application of recognised W/m² rules.

b) **New Loads:** Unless actual design data is available the maximum demand of new facilities can be estimated by the careful application of W/m² rules.

c) **Load Growth:** In projecting electrical demand on high voltage systems an annual load growth of 3% shall be used unless otherwise approved by DEEP.

The Ultimate Base Load shall include allowance for the above existing load, new load and load growth categories. Ultimate Base Load must be agreed by DEEP.

**Primary and Secondary Distribution**

**System Configuration**

In determining the proposed system configuration the key considerations shall be the reliability and redundancy provided by the arrangement.

For larger establishments the following shall be features of the arrangement:

a) At least two incoming feeders into the establishment;

b) Incoming feeders connected to separate distribution nodes consisting of HV switchboards to which the secondary distribution is connected;

c) Interconnector cables run between the distribution nodes to enable power transfer between them;

d) Distribution substations connected on ring mains that run from one primary node to another one.

e) Centralised emergency power generation (if provided) is co-located with one of the distribution nodes, preferably with the standby feeder.

For all configurations, particularly those involving multiple supplies running in parallel a basic load flow study shall be required to confirm viability. The load flow study must confirm a full alternate supply to distribution substations on the failure of any single element of the distribution system.

**System Capacities**

The System components shall generally be sized as follows:

a) **HV Cables Generally:**
- Sized for a minimum fault level of 250 MVA for one second;
- Sized for a minimum capacity of 4 MVA when all derating factors are applied, and
- Constructed using a minimum 120 mm\(^2\) Cu/XLPE or equivalent aluminium conductor.

b) **Incoming Feeders and Primary Substation Transformers:** Sized for the Ultimate Base Load. The Second feeder can be a lower capacity feeder; however this is subject to an NPV analysis and will require approval from DEEP. Where incoming supply is by transformers there shall be a minimum of two transformers arranged to maintain full supply in the event of a primary transformer failure.

c) **Interconnectors:** Sized to accommodate the power transfer that can occur under the worst case condition, including single contingency failure or worst-case configurations, such as when the ring main open points are all shifted to one end.

d) **Ring mains:** Sized to accommodate the worst-case load and voltage drop that can occur when the open point is shifted to one end. At establishments with a single interconnector this shall also include consideration of through load conditions that may exist if the interconnect has failed. The ring main rating used in the design shall consider the installation method of the cable. In most instances cable will be direct buried but there could be significant lengths installed in conduit under paved surfaces. In general the rating should be for installation in conduit. To allow for uneven loading of the rings and for future loads to be connected, the master planned loading on ring mains should generally not exceed 60% of cable capacity. Any development exceeding this limit requires DEEP approval.

**Site Selection**
Primary substations/switching stations and power stations shall generally be located within the higher security zones of the establishment.

The detailed site of major plant shall be selected in accordance with the site selection criteria given in Chapter 26 — High and Low Voltage Distribution System Requirements.

**Emergency Power Generation**

**Requirement**
Certain loads are provided with standby power in the event that the mains supply fails. In addition, certain operational establishments are provided with a CEPS. The master plan shall consider the operational requirements for standby power generation for the existing and new loads. This shall include:

a) The types of operations conducted and the consequence of power supply interruptions;

b) Current practice at the establishment;

c) Normal Defence practice in providing standby power;

d) The reliability of the electrical supply.

Depending upon the nature of the loads requiring standby power and their geographic distribution the master plan shall recommend either:

a) Local power generation using LEGs at each facility;
b) Centralised power generation using a CEPS, or

c) A combination of both, with LEGs powering building essential loads and a CEPS providing site power.

**CEPS Capacity**

Should a CEPS be proposed the master plan shall recommend a capacity taking into account the availability of load shedding or other load control measures and either:

a) The magnitude of the loads requiring standby power from the Ultimate Base Load calculations, or

b) A percentage of the total establishment load (e.g.: typically 70% for operational RAAF bases) based on operational experience.

**Site Selection**

Centralised power generation should generally be located within the higher security zones of the establishment.

The detailed site of a CEPS major plant shall be selected in accordance with the site selection criteria for switching stations given in Chapter 26 —High and Low Voltage Distribution System Requirements. In any case the CEPS should be located a minimum of 400 metres from the connection point for the primary incoming feeder from the NSP (typically the ISS).

### 3.1.4 Master Plan Report

For the requirements for the structure and content of Master Plan Reports, refer to Chapter 4 —**Error! Reference source not found..**

### 3.2 High Voltage System Development Plans

#### 3.2.1 Development Plan Considerations

A High Voltage Development Plan is a plan produced either as a precursor to or as part of the Concept Design Report for a particular project that details the extent of work to be executed under that project and demonstrates how this is consistent with the master plan. In this it is similar to detailing the staging of the works under a master plan and so it needs to meet the same requirements but is tailored to a particular development activity.

Where a master plan report does not exist the Development Plans shall indicate how the proposed works will fulfil the infrastructure needs of the current project and not limit future development of the electrical infrastructure needed for possible future developments. In essence it must fulfil the basic master planning principles described above for master plans.

The key considerations in the formulation of a Development Plan are that the proposed works are:

a) Consistent with the Master Plan;

b) Meet the immediate electrical supply needs of each project while minimising capital expenditure both for the project and long term;

c) Minimise redundant work at each stage.
Development plans shall be submitted for DEEP approval prior to their circulation.

### 3.2.2 Development Plan Format

For formatting requirements for Development Plans, refer to Chapter 4 — Documentation Standards.