4 Documentation Standards

4.1 Background
This chapter defines the technical standards for documentation of electrical power generation and distribution systems at Defence establishments. This policy includes requirements for:

a) Electrical Master Plans and Development Plans;
b) Standard Drawing Arrangements;
c) System Documentation and Operational Drawings;
d) Design Reports;
e) Design Documents;
f) Shop Drawings and Submissions; and
g) As Installed Documents and Operation and Maintenance Manuals.

Documentation for the following systems is included:

a) Site plans and cabling layout drawings;
b) Equipment layout drawings.
c) High voltage systems including:
   • Protection systems, including:
     • AC and DC schematics, and
     • Protection schemes;
   • Load Flow and Volt Drop Analysis

d) Power generation systems, including:
   • Engines;
   • Fuel systems;
   • Cooling systems;
   • Starting systems;
   • Alternators, and
   • Associated control system.

   Low voltage primary systems;
   a) Control and instrumentation systems;
   b) Other auxiliary systems, such as On Load Tap Changers;
   c) Auxiliary power systems; and
d) Earthing systems.
This chapter provides guidance and detailed technical material as necessary to define the Defence documentation requirements and standards to be applied, in addition to the applicable statutory regulations and standards.

4.2 Referenced Documents

All documentation shall be of the best standard and shall comply with the relevant Australian Standards, or if such do not exist, with the relevant IEC or International (ISO) Standards. Irrespective of any requirements shown in this manual the documentation as a whole shall comply with:

- **Australian Standards**
  - AS/NZS 1102 *Graphical Symbols for Electrotechnical Documentation (series)*
  - AS/NZS 3000 *Wiring Rules.*
  - AS 2067 Substations and high voltage installations exceeding 1 kV a.c.
  - AS 3702 *Item Designation in Electrotechnology.*

- **Other Standards**
  - The rules and regulations of the relevant NSP.
  - IEC 61131-3 *Programmable Controllers – Programming Languages*

The requirements of any other Authority having jurisdiction over the installation.

- **Technical References**
  - No Technical References are utilised.

4.3 Documentation Process

4.3.1 Requirements of the Designer and Contractor

The designer and contractor are responsible for complying with the requirements of this chapter, the additional requirements outlined in the FDB and the requirements of regulations and standards. This responsibility encompasses documenting the installation and specifying equipment to meet the required standards and also verifying that the final as installed, and operational and maintenance documentation, when completed, complies with these requirements.

The Designer and Contractor must also ensure that the documentation is adequately detailed so that the identified procedures and activities can be undertaken safely and reliably in the facility.

In addition to the requirement for design documentation such as specifications and drawings, the Designer must provide design reports and other reports as outlined in the IM *Design Management* requirement, this manual and any other technical investigations or reports as detailed in the FDB.
4.3.2 Requirements of the Electrical Operating Authority/Network Controller

The Electrical Operating Authority (EOA)/Network Controller (NC) is responsible for maintaining up to date operational drawings as described in Para 4.6 — Requirement for System Documentation and Operational Drawings of this document. This responsibility includes ensuring that the documentation provided by the designer for any alteration or addition complies with these requirements and has been appropriately incorporated into the Base/Establishment records.

4.4 Documentation Standards

Defence attaches considerable importance to the provision of proper documentation of the design (including specification, drawings, datasheets etc) and due regard shall therefore be paid to the detail and completeness of such documents. Documentation shall be clear, concise and precise.

4.4.1 Specification of Equipment

Unless special circumstances exist, equipment and materials shall not be specified by make and model number but shall be selected on the basis of their performance, suitability, availability, maintainability and cost effectiveness. Any proposal to specify equipment by make and model shall be formally documented for approval by Defence.

4.4.2 Text Documentation Format

The format of all text documentation, whether this is for the Functional Design Brief (FDB), Concept Design Report (CDR), design specifications, data sheets, Operation and Maintenance Manuals or any other Design Reports shall be generally as follows:

a) The page size shall be A4 but may be A3 where drawings are also incorporated.

b) Shall be provided in both Microsoft Word and PDF formats

c) New sections shall commence on new pages.

d) A revision box shall be included at the beginning of each document with:
   – Revision number;
   – Author;
   – Checked;
   – Approved; and
   – Date.

4.4.3 Drawings Format

The drawings shall be clearly legible when printed on A3 size sheets.

All drawings shall be to a professional standard and drawn in accordance with the relevant Australian, IEC or International (ISO) Standards. Drawings shall be provided in both their native format (e.g. DGN, DWG) together with the relevant reference files, colour tables and line styles and also in PDF format.

Where appropriate, the drawing scale must be shown. The drawing shall also include a graphic scale to facilitate scaling when a sheet is reproduced at a different size to the original.
All drawings shall have a revision box containing:

a) Revision number and status;
b) Designed;
c) Drawn;
d) Checked;
e) Approved; and
f) Date.

**Non-standard Symbols**

Symbols shall comply with Australian Standards.

Where the use of non-standard symbols is unavoidable, reference to the symbol(s) shall be made in the form of a legend on the drawing, accompanied by explanation and description.

### 4.5 Requirements for Electrical Master Plans and Development Plan Reports and Drawings

#### 4.5.1 Electrical Master Plan

**Introduction**

The Electrical Master Plan report shall document in detail the factors considered in the master planning process. These considerations are listed in detail in Chapter 26 – High and Low Voltage Distribution System requirements.

Electrical Master Plan and Development Plan reports must carry signature acknowledgement from DEEP before they may be circulated.

**Report Format**

The Electrical Master Plan shall consist of a written report with drawing attachments as required. The following is a representative outline of the report. This outline is provided for guidance only and all sections might not be applicable in all instances.

**Existing Installation**

**Incoming Supply**

a) Configuration of the incoming supply including its source and voltage.
b) Any limitation on the capacity of supply as a result of factors in the DNSP’s network;
c) The condition of the DNSP assets;
d) Factors negatively effecting reliability of the incoming supply;
e) Redundancy issues, including the alternative mains connections.

**Existing Loads**

a) The types of loads at the establishment;
b) Magnitude of the load;
c) Electrical characteristics of the load, such as power factor or load fluctuations;  

d) The distribution of load across the establishment;  

e) The load profile of the load across the day.  

- **Primary Distribution and PSS**  
  a) Configuration of the primary distribution;  
  b) Feeder/Interconnector capacity including their construction and capacity;  
  c) HV switchboard arrangement and capacity;  
  d) Space limitations;  
  e) Condition and age of the assets;  
  f) Reliability and Redundancy issues.  

- **Secondary Distribution and Distribution Substations**  
  a) Configuration of the ring mains;  
  b) Ring main capacity including their construction and capacity;  
  c) Distribution substation arrangement and capacity;  
  d) Condition and age of the assets;  
  e) Reliability and Redundancy issues.  

- **Central Emergency Power Station**  
  a) Configuration of the station:  
     - Capacity and connection arrangements of the generators;  
     - Physical arrangement of the building and generating halls;  
  b) Operation of the control system, including any limitations on automatic operation;  
  c) Condition and age of the plant;  
  d) Reliability and Redundancy issues.  

- **Control and Monitoring Systems**  
  a) Configuration of any control and monitoring systems, in particular systems that:  
     - Monitor the status or power flows in the electrical distribution system, or  
     - Provide control of load shedding devices;  
  b) Capabilities of the systems;  
  c) Interfaces to other systems;  
  d) Condition and age of the plant.  

**Deficiencies**  

The main deficiencies of the existing systems in:  

a) Meeting the existing loads;
b) Limiting the future expansion;
c) Limiting long-term supportability;
d) Ensuring acceptable reliability of operation.

- **Loads and Ultimate Base Load**
  a) The types of proposed new loads and demolitions;
  b) Magnitude of the load;
  c) Electrical characteristics of the load, such as power factor or load fluctuations;
  d) The distribution of load across the establishment;
  e) The load profile of the load across the day.

- **Drawings**
  a) Existing system;
     - SLD;
     - Geographic layout.
  b) Electrical Master Plan
     - Loads and load zoning;
     - SLD;
     - Geographic layout.

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.

  Electrical Master Plan and Development Plan reports must carry signature acknowledgement from DEEP before they may be circulated.

- **Drawing Requirements**
  Drawing Requirements are provided at paragraph 4.5.3—Standard Arrangement Drawings.

**4.5.2 Electrical Development Plan**

- **Introduction**
  An Electrical Development Plan is a plan produced, often as part of the Concept Design Report for a particular project, which details the extent of work to be executed under that project and 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.
Report Format

a) A report, usually as part of the CDR for the project, that details;
   – The proposed works, including a description of how these conform to the master plan;
   – Estimates for each stage.

b) Drawings accompanying the report;
   – SLD for each stage;
   – Geographic layout for each stage;
   – Loads and load zoning, where differing from master plan.

Where there is no master plan report the Electrical Development Plan will also need to include the relevant detail as described above for the Electrical Master Plan report.

4.5.3 Standard Arrangement Drawings

High Voltage Master Plan Zone Plan - Load Zoning Diagrams
Zone diagrams are planning documents that detail the location of the various load types in the site. The load types are loads with different functions, such as operational loads, domestic load and support loads. For this purpose it is preferred that the layout occupy a single sheet, using colour for increased clarity. Each load type shall be identified on the plan as a hatched area with a different colour. Sample zone plan diagram drawing is provided at Figure 4.1.

High voltage Single Line Diagrams
Single line diagrams are planning documents that show the broad configuration of the HV network. For this purpose it is preferred that the SLD occupy a single drawing sheet able to be reproduced in black and white. The SLD shall detail the HV system down to the transformers at distribution substations, including the rating of the distribution transformer. Sample high voltage single line diagrams are provided at Figure 4.2.

High Voltage Geographic Layouts
Geographic layouts are planning documents that detail in broad terms the physical location of substations and HV cables at a facility. For this purpose it is preferred that the layout occupy a single sheet, using colour for increased clarity. For large networks it might be necessary to separately document the primary and secondary distribution networks.

The high voltage geographic layout shall detail:

a) The location of Intake Stations, primary switching stations, power stations and distribution substations;

b) The route of the incoming supply;

c) The route of primary distribution;

d) The route of secondary distribution.
Sample geographic layout drawing is provided at Figure 4.3.

Substation Single Line Diagram is provided at Figure 4.4.

Switching Station Single Line Diagram is provided at Figure 4.5.

Low Voltage Distribution Pillar Schematic is provided at Figure 4.6.

Standard Symbols are provided at Figure 4.7.
Figure 4.1: High Voltage Master Plan Zone Plan
- Figure 4.2: High Voltage Single Line Diagram
Figure 4.3: High Voltage Geographic Layout
**Figure 4.4: Substation Single Line Diagram**

- **HV SWITCHGEAR**
  - MAKE:
  - TYPE:
  - BUS / SWITCH RATING:
    - HV FUSE
    - TYPE:
  - HV TRANS. TAILS
    - No:
    - SIZE:
    - TYPE:

- **Transformer**
  - MAKE:
  - TYPE:
  - RATING:
  - IMPEDANCE:
  - VECTOR GROUP:
  - TAPPINGS:
  - LV TRANS. TAILS
    - No:
    - SIZE:
    - TYPE:
  - LV BOARD
    - MAKE:
    - TYPE:
    - BUS RATING:

- **LV LABEL TRANSFORMER**
  - NO:
  - TYPE:
  - RATING:
  - TYPE:
  - MAKE:
  - IMPEDANCE:
  - VECTOR GROUP:
  - TAPPINGS:
  - BUS RATING:
  - MAKE:
  - TYPE:

- **CABLE SIZE/TYPE**

- **NOTES:**
  1. PROTECTION SETTINGS SHOWN HERE WHERE POSSIBLE OTHERWISE REFER TO APPROPRIATE H.V. PROTECTION TABLE.
  2. FOR LEGEND REFER TO FIGURE 4.7

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MIEE 2011, Amend1 – 15 Sept 2010       Chapter 4 - Documentation Standards       Page 12 of 30
### Table 4.5: Switching Station Single Line Diagram

<table>
<thead>
<tr>
<th>No.</th>
<th>CCT</th>
<th>HV Label</th>
<th>CABLE SIZE/TYPE</th>
<th>Notes</th>
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**Physical Arrangement - Elevation (Viewed from front)**

**Figure 4.5: Switching Station Single Line Diagram**

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**Notes**
1. Protection settings shown here where possible, otherwise refer to appropriate high-voltage protection table.
2. For legend refer to Figure 4.7
LV BOARD

MAKE: 
TYPE: BUS RATING:

SWITCHGEAR

MAKE: 
TYPE: 

<table>
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<th>LV LABEL</th>
<th>CABLE SIZE/TYP</th>
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**Figure 4.6: Low Voltage Distribution Pillar Schematic**

```
* FUSE CARTRIDGE INSTALLED
FUSE CARRIER SIDE

FOR LEGEND REFER TO FIGURE 4.7
```
### Figure 4.7: Standard Symbols
4.6 Requirement for System Documentation and Operational Drawings

System Documentation and Operational drawings are those documents and drawings that aid in the operation of the equipment and system. They are used by operators and are also displayed adjacent to equipment as detailed below:

Operational drawings shall be provided as follows:

a) Within distribution substations:
   - Substation single line diagram (min. A4 size)
b) Within LV distribution pillars:
   - Pillar single line diagram (min. A4 size)
c) Within major substations and switching stations:
   - HV switchboard single line diagram (min A1 size)
   - Site HV system single line diagram (min A1 size)
   - Site HV system geographic layout (min A1 size)

The operational drawings shall be securely fixed to the wall.

A4 size drawings can be laminated. All other drawings shall be mounted in heavy-duty metal frames with a glass cover.

Sample drawings showing the expected general standard and layout of the drawings are included in paragraph 4.5.3 — Standard Arrangement Drawings.

- High Voltage System Configuration Manual

The High Voltage System Configuration Manual (HVSCM) is an aggregation of system documentation and operating drawings which detail all aspects of the Base HV network as it currently operates. The intent for this document is to centralise information that describes the electrical network so that it is readily available for reference by Defence, the CMS or external parties. It should act as a reference for any switching operations, field inspections or consultation.

The EOA is responsible for developing and maintaining an appropriate HVSCM. Where HVSCM is inadequate or incomplete, the Designer is to produce a HVSCM, which shall incorporate the most recent versions of:

a) HV Single Line Diagram (refer paragraph 4.5.3 — Standard Arrangement Drawings.);
b) HV geographic layout (refer paragraph 4.5.3 — Standard Arrangement Drawings.);
c) Substation / Switching Station schematics (refer paragraph 4.5.3 — Standard Arrangement Drawings.);
d) LV DP schematics (refer paragraph 4.5.3 — Standard Arrangement Drawings.);
e) HV protection study report, HV earthing study report and Load flow study report (refer paragraph 4.7.1.1 — Content Requirements for High Voltage Installation Reports); and
f) Appropriate reference to the O&M manuals and shop drawings.
The Electrical Operating Authority is responsible for maintaining the HV System Configuration Manual and shall hold this document on site. An electronic copy shall be provided to DEEP.

4.7 Requirements for Design Reports

The requirement for documentation varies depending upon which systems are being designed in the project. In general if a system forms part of the project the following levels of detail in the documentation shall be provided at each respective stage.

4.7.1 Design Report Requirements

The Designer shall submit design reports as required by the IM Design Management process and in accordance with the respective project requirements. In summary design reports for electrical systems will be required, as a minimum, at the following stages for DEEP review:

a) Concept Design Stage (Concept Design Report (CDR));
b) Schematic Design Stage (Schematic Design Report (SDR)), and
c) Depending on the suitability of the above submissions, as further required by DEEP, typically:
   – Detailed Design Stage (Detailed Design Report (DDR));
   – Final Design Stage (Final Design Report (FDR)).

DEEP will advise after reviewing each design report (e.g. CDR and SDR) the need for further design report submissions for review.

It is expected that the design report will be continually developed during the design process in a regular fashion until completion of the design where a Final Design Report (100% design) is provided for inclusion in the Operation and Maintenance information. All design report revisions submitted for review shall have changes clearly tracked within the document to assist review.

The design report shall identify all key design objectives and clearly identify the design intent providing the logic behind design decisions, so that concurrence can be given to such decisions.

The commentary shall fully describe the design intent and parameters that will be provided by the constructed facility. The Design Report shall include sketch plans or drawings of the installation layout in accordance with the requirements below.

The content of electrical design reports shall include:

a) MIEE Compliance Report as detailed in Chapter 6 —Certification and Verification and Appendix A;
b) Suitable discussion addressing the Design Considerations at Appendix A and the additional requirements provided below;
c) Proposed scope of works and detail the system arrangement;
d) All major regulations and standards, Defence policies and guidance publications and detail their extent and field of application;
e) Where the design deviates from any of the stated requirements, provide fully justified submissions in accordance with the Alternates Methods and Design process at Chapter 6 —Certification and Verification for Defence agreement and Technical Authority approval.

f) Detail the proposed point of supply for each facility including the supply capacity/characteristics/condition assessment demonstrating adequate capacity is available at the point of supply, the reticulation system and the NSP supply to the establishment;

g) Detail any proposed reticulation system modifications;

h) Facility maximum demand assessment and load characteristics;

i) Switchboard locations, design fault level, voltage drop allocation, circuiting arrangements, earthing arrangements and protection arrangement;

j) Basis for sizing of major equipment;

k) Include layout drawings and single line diagrams for the proposed arrangement;

l) Detail the system operation where appropriate; and

m) Certify that the design meets the requirements of the FDB, this manual, the IM and the requirements of the regulations and standards identified above;

Additional design report content for key subject areas.

- **Residual Current Devices Reporting Requirements**
  a) All socket outlets not RCD protected are detailed in the design report for agreement and shock risk hazard assessment included with the report

- **Power Factor Correction Installations Reporting Requirements**
  a) Feasibility assessment and payback period;
  b) Detail the PFC system, location and the basis for sizing/selecting of capacitor steps.

- **Artificial Lighting Installations Reporting Requirements**
  a) Proposed lighting system performance including operational considerations and levels of illumination for each area;
  b) Financial assessment and cost benefit studies to justify the chosen lighting system;
  c) Detailed description of the control system type and arrangement including justification of the arrangement chosen and detail on the control interfaces (e.g. BMS and SMS);
  d) Detailed description of the energy management and energy efficiency initiatives;
  e) Any specialised maintenance requirements, and
  f) Luminaire types and lamp types where appropriate.

- **400Hz Design Reporting Requirements**
  a) Detail the frequency converter and reticulation system arrangement;
  b) Detailed description of the control system;
  c) Detail the connection arrangement or socket outlet arrangement;
  d) Facility maximum demand assessment and load characteristics;
e) Detail the supply characteristics/conditions, design fault level and assessment showing the ability to maintain the required supply characteristics for all load conditions;
f) 400Hz Switchboard locations, voltage drop allocation, circuiting arrangements, earthing arrangements and protection arrangement;
g) Basis for sizing of major equipment such as converters and transformers, and
h) Include layout drawing and single line diagram for the proposed arrangement.

- **Hazardous Areas and Explosives Areas Installations Reporting Requirements**
  a) Detail the Hazardous Areas and Explosives area standards being applied;
  b) Detail the competencies of the designers;
  c) Detailed classification description including detail of the processes and hazards;
  d) Hazard analysis report where required by Chapter 15 — Hazardous Area and Explosive Area Electrical Installations;
  e) Design limitations and management practices for the facility impacting on classification or safety;
  f) Any specialised maintenance requirements; and
  g) Include layout drawings, single line diagrams and hazardous area zone plan for the proposed arrangement.

- **UPS Reporting Requirements**
  a) Detail the proposed accommodation for the UPS;
  b) Detail the UPS and critical reticulation system arrangement;
  c) Detail the system operation and control system where appropriate;
  d) Detail the failure recovery strategy, availability and redundancy;
  e) Detail the connection arrangement and impact of NSP rules;
  f) Facility maximum demand assessment and load characteristics;
  g) Detail the supply characteristics/conditions, design fault level and assessment showing the ability to maintain the required supply characteristics for all load conditions;
  h) Critical switchboard locations, voltage drop allocation, circuiting arrangements, earthing arrangements and protection arrangement;
  i) Basis for sizing of major equipment such as UPS and critical power system
  j) Battery capacity and hold up period;
  k) Justification for the chosen system; and
  l) Include layout drawing and single line diagram for the proposed arrangement and control panel layout drawings.

- **LEG Reporting Requirements**
  a) Detail the generator and essential reticulation system arrangement;
  b) Detailed description of the control system;
  c) Detail the connection arrangement and impact of NSP rules;
  d) Facility maximum demand assessment and load characteristics;
c) Detail the supply characteristics/conditions, design fault level and assessment showing the ability to maintain the required supply characteristics for all load conditions;
f) Essential switchboard locations, voltage drop allocation, circuiting arrangements, earthing arrangements and protection arrangement;
g) Basis for sizing of major equipment such as generator and essential power system, and
h) Include layout drawing and single line diagram for the proposed arrangement and control panel layout drawings.

**Mobile Generator Link Box Reporting Requirements**

a) Include layout drawing and single line diagram for the proposed arrangement and MGLB switchboard/panel layout drawings.

**CEPS Reporting Requirements**

a) CEPS demand assessment
b) Building layout;
c) Detail the generation system including:
   - Generating sets
   - Mechanical systems, including ventilation, fuels system, fuel storage capacity, cooling system,
   - Electrical systems including the earthing arrangements and protection arrangement
   - Control hardware and software
   - Communications networks
   - Operating philosophy
   - Load shedding philosophy
d) Passive defence
e) Detail the connection arrangement and impact of NSP rules;
f) Basis for sizing of major equipment such as generators; and
g) Include layout drawings and single line diagram for the proposed arrangement and control panel layout drawings.

**4.7.1.1 Content Requirements for High Voltage Installation Reports**

**Design Reports up to and including CDR**

The following supporting documents for each system shall accompany the report:

a) Site plans showing cabling layout and the location of the works;
b) Electrical Development Plan if necessary (refer to Chapter 3 – High Voltage System Master Plans and Project Development Plans, Chapter 26 – High and Low Voltage Distribution System Requirements and Appendix A);
c) Substation and major plant room layout drawings showing building and all major equipment locations;
d) Single line diagram of the relevant portions of the establishment HV system putting the works in the context of the network. These drawings should show the general configuration;

e) Single line diagrams of LV primary systems showing the general configuration of the system;

f) System Documentation and Operational Drawings described at paragraph 4.6 – Requirements for System Documentation and Operational Drawings;

g) Control topology drawings where this has been developed sufficiently;

h) Basic layout drawings showing building and principal equipment locations. Dimensions are not required unless these are critical items;

i) Preliminary load analysis; and;

j) Preliminary protection system analysis.

- Design Report Drawing Details

In addition to the requirements above and elsewhere in this Chapter (4) the following applies for high voltage installations:

- Substation and Major Plant Room Layout Drawings

Provide site plan, substation/plant room layout drawing. The substation layout drawings are required for all indoor substations. They shall be 1:50 scale showing the substation arrangement including the layout of the equipment and the arrangement of all pits and conduits.

The drawing shall be fully dimensioned and must show HV switchgear, transformer, LV switchboards, protection panels, batteries and battery chargers, communications panels, SCADA equipment, fire extinguishers, equipment storage and drawing holders. The plans must also detail the ventilation arrangement and also the access and egress paths.

The layout drawing shall incorporate a plan view showing the location, sizes and depths of pits and connecting conduits. This view should indicate the step heights, oil containment arrangement, pit grading and sumps and approximate position of the earthing system. This plan view shall be incorporated as separate views where there is too much information to provide on a single drawing.

- Design Reports after CDR

The following supporting documents for each system shall accompany the report:

a) Site plans showing cabling layout and the location of the works;

b) Substation and major plant room layout drawings showing building and all major equipment locations;

c) Single line diagram of the relevant portions of the establishment HV system putting the works in the context of the network;

d) Single line diagrams of each major substation, HV switching station and distribution substation showing the general configuration, and protection that is proposed;
e) Detailed single line diagrams of each HV switchboard panel type showing the detailed configuration, protection and control proposed. These drawings should show details of CTs and VTs, including ratios, classes and burdens;

f) Single line diagrams, cable schedules etc of LV primary systems showing the detailed configuration of the system, cable sizes, protection ratings etc;

g) Revised System Documentation and Operational Drawings described at 4.6 – Requirements for System Documentation and Operational Drawings;

h) Control topology / network drawings;

i) Single line diagrams of all ancillary electrical supplies, such as DC systems;

j) Details of any On Load Tap Changing arrangements;

k) Details of earthing systems, including layout drawings and schematic drawings;

l) Generating plant auxiliary system schematics, such as those for fuel and compressed air;

m) Results of load flow analysis for the system under normal operating and worst-case single contingency failure conditions. This must include confirmation of suitable volt regulation/volt drop analysis; and

n) Results of the protection coordination study and protection system analysis.

**Additional Reports Design Reports after CDR**

Generally, unless formally agreed by DEEP otherwise, the following reports shall be prepared. The required timing for the first issue of the reports is concurrent with the issue of the SDR. The final issue of the reports shall occur shortly after comment by DEEP and in no case later than the issue of For Constructed documentation.

**Earthing Report**

An earthing report shall be prepared where the works:

a) Require the construction of new major substations or switching stations, or

b) Result in a significant change in HV fault levels.

This report shall be based on on-site measurements of soil resistance and shall detail:

a) The earth fault levels at each bus;

b) Earth potential rise in the vicinity of the substation under maximum prospective fault levels;

c) The step and touch potentials within and in the vicinity of the substation, and

d) Measures adopted to minimise transfer potentials as part of the design.

**Protection Report**

A review of the HV protection settings is required and a protection report shall be prepared where the works:

a) Require the construction of new major substations or switching stations;

b) Require changes to the distribution system that will result in a need to change the protection settings, for example:

c) Changes to Primary Configuration
d) Adding a generator, Interconnector, Ring main, etc; or

e) Result in a significant change in HV fault levels.

The protection report shall include:

a) A study of the system fault levels to determine the maximum and minimum prospective fault levels at each bus under various system configurations;

b) A statement of the protection philosophy that has been implemented;

c) A grading study for IDMT protection under all system configurations;

d) Setting information for IDMT protection elements;

e) Setting information for all unit protection schemes, and

f) Setting information for all other protection elements.

Setting information shall be supported by calculations, that are included as part of the report. Settings shall be provided in engineering terms only.

The results of the protection study shall be implemented in the design.

- **Load Flow Report**

  The purpose of a load flow report is to predict the areas of poor performance or potential overload at various points in the electrical network under different operating conditions.

  A load flow report shall be prepared where the works:

  a) Increase, offset, or otherwise alter electrical load magnitudes and their distribution across the Base; or

  b) Require the construction of new major substations or switching stations;

The load flow report shall be based on a model of the electrical network developed in a known electrical simulation software package suitable for conducting load flow studies. Simulations shall be carried out for both normal operating conditions and single contingency situations and shall include:

a) Summary of load flows in the network, identifying sections that may be overloaded or operate outside of specification;

b) Information on voltage drop at each bus; and

c) Information on current flow at each node in the network.

The outcome of the load flow study shall guide the design.

### 4.8 Requirements for Design Documents

- **Tender and ‘For Construction’ Documents**

  Tender and ‘For Construction’ documents consist of specifications, data sheets, drawings, reports and other documents are required to suit the project.

- **Specifications**

  Specifications shall address the following points, as applicable:
a) Define the scope of works;
b) General establishment and service conditions data, taking into account data from the Bureau of Meteorology and any special site requirements;
c) General construction standards, methods and materials;
d) Details of the works that have not been included on the drawings or elsewhere;
e) Control philosophies to be implemented.

Data Sheets
Data sheets shall address the following points, as applicable:
a) Description of the equipment;
b) Applicable standards;
c) Equipment characteristics;

Drawings
As a minimum, drawings shall include the following, as applicable:
a) Site plans showing cabling layout and the location of the works;
b) HV single line diagram of the relevant portions of the establishment HV system putting the works in the context of the network;
c) Single line diagrams of each major substation, HV switching station and distribution substation showing the general configuration, and protection that is proposed;
d) Detailed single line diagrams of each HV switchboard panel type showing the detailed configuration, protection and control proposed. These drawings should show details of CTs and VTs, including ratios, classes and burdens;
e) LV single line diagrams, cable schedules etc of LV primary systems showing the detailed configuration of the system, cable sizes, protection ratings etc;
f) Control topology / network drawings;
g) Loop drawings if considered necessary to describe the system;
h) Single line diagrams of all ancillary supplies, such as DC systems;
i) Details of earthing systems, including layout drawings and schematic drawings;
j) Protection Reports and protection coordination; and
k) Layout drawings showing building and all major equipment locations. Dimensions are not required unless these are required for coordination purposes.

4.9 Requirements for Shop Drawings
The provision of shop drawings shall be included in the specification covering all aspects of the works. The Designer shall review the shop drawings and any other technical submissions to ensure that the proposed works comply with the design intent and that they are fully compliant with the requirements contained herein and applicable standards.

As a minimum, drawings shall include the following, as applicable:
- **Cabling**
  a) Cable schedules, field wiring diagrams and interconnection cabling diagrams, including cable sizes and constructions.
  b) The final locations of cables, pits, cable joints, cable ladders etc;

- **Electrical Panels and Switchboards Generally**
  For all electrical switchboards and panels provide the following shop drawings:
  a) General Assembly drawings showing the arrangement of the switchboard. This shall include details of:
     - Materials;
     - Construction;
     - The location of equipment both externally and internally;
     - Busbar details;
     - Painting;
     - Labelling;
     - Door details;
  b) A single line diagram of the entire switchboard;

- **HV Switchboards**
  Provide the following additional shop drawings for HV switchboards:
  a) An AC drawing for each panel including a three line diagram showing:
     - The primary system configuration of busbars, circuit breakers and earth switches.
     - All metering, control and protection devices, including model numbers and terminal numbers.
     - The details and arrangement of the CTs and VTs, and the secondary cabling, including wire numbers.
     - Terminals and test link, including terminal numbers.
  b) A DC drawing of each panel showing:
     - All metering, control and protection devices, including terminal numbers.
     - The arrangement of DC cabling, including wire numbers.
     - Details of terminals, including terminal numbers.

- **MCCs, Control Panels, DC supplies, etc**
  Provide the following additional shop drawings of each MCC, Control Panel and any major component containing control circuitry.
  a) Schematic drawings showing:
     - Details of all equipment, including terminal numbers;
     - Details of control and communications cabling, including wire numbers;
     - Details of terminals, including terminal numbers.
– Ammeter scales and current transformer ratios;
– Circuit breaker and fuse current ratings;
– Ratings of capacitors, resistors and any other electrical devices;
– A short name description of each relay, timer or control device to describe its operation;
– A cross-reference system that indicates where each contact for a relay or timer is located. The system may include sheet and line numbers;

**PLC and Instrumentation Systems:**

Provide the following additional shop drawings for systems containing PLCs or instrumentation systems:

b) Control topology / network drawings;
c) I/O schedules and drawings;
d) Loop drawings for instrumentation.

**Major Plant, such as Transformers**

a) Functional description;
b) Integral protective devices (Buchultz, vector group);
c) Cooling arrangement;
d) OLTC arrangement;
e) Overall dimensions and mass (including the mass of the heaviest lift for maintenance);
f) Terminal point details;
g) Minimum clearances;
h) Where plant or plant items subject to pressure and temperatures higher than ambient;
   – Design pressures and temperatures;
   – Working pressures and temperatures;
   – Test pressures and temperatures;
i) Insets, where necessary, to ensure every item of the assembly is clearly shown;
j) All points of support;
k) All points of attachment of the plant to piping, conduits or other items supplied by others;
l) Location of holding-down bolts or other points of support or anchorage.

### 4.10 Requirements for As-Installed Documentation and Operations and Maintenance Manuals

#### 4.10.1 As Installed Documentation and Drawings

The provision of as-installed documentation shall be included in the specification covering all aspects of the works. At the completion of construction, both the ‘For Construction’ design drawings and Shop Drawings shall be updated to reflect any changes that have occurred during the construction phase. Notwithstanding the requirement for the contractor to provide accurate and adequate documentation, the Designer shall verify that the updates and all as-installed documentation accurately reflect the constructed equipment and installation.
4.10.2 Operation and Maintenance Manuals

Comprehensive Operations and Maintenance (O&M) Manuals shall be provided so as to enable efficient operation and maintenance of the installation. Perform all necessary amendments to the operation and maintenance manuals to ensure formal acceptance by the CMS.

Where existing O&M manuals exist that cover the installation these shall be incorporated into the new manuals, unless the modifications are minor in nature and their amendment is agreed by Defence. Depending upon the scope of works and the condition of the existing manuals this can be done in either of two ways:

a) The new manuals shall incorporate the relevant sections of the existing manuals, or
b) The existing manuals shall be updated to reflect the new works.

In any case information on redundant equipment shall not be left in the manuals.

The manuals shall contain short and long form operating instructions and a comprehensive maintenance schedule.

The text of the Operating and Maintenance Manuals, together with all drawings, illustrations and diagrams shall refer specifically to the Equipment being supplied, and shall be specially prepared where necessary. General instructions referring to a range of typical equipment will not be acceptable.

- **Binders**

The Operating and Maintenance Manuals shall be assembled and bound in a four ring A4 binder of the heavy duty, swing hinge, split prong type, of stiff binder board construction designed for rough usage. The binder shall have the title of the project, equipment description and the Contractor's name, imprinted on the spine and front cover.

Binders shall not exceed 75 mm in thickness. If required by the quantity of instruction manual material, multiple volumes shall be supplied, each clearly marked with the volume number. Each volume shall contain a full index for the entire manual and also a detailed index for its own content. A sufficient number of volumes shall be provided so that the material contained in each volume (including drawings, if any) does not use more than 80 percent of the binder capacity.

- **Content**

The instructions shall be fully detailed covering all new equipment supplied. Unless the modifications are minor in nature and the existing manuals are being amended, the manuals shall also incorporate details of any existing equipment that has been retained and the existing manual information can be used for this purpose if suitable. The manuals shall include the following:

a) Table of contents and index tabs;

b) Specifications, test data (including all works and site tests), performance and equipment characteristic curves;
c) Description of the equipment and components. This should include an overview with block diagrams and detail descriptions;
d) Short form and long form operating procedures;
e) Comprehensive control system description including control methodology;
f) Complete and detailed step by step operating instructions, including setting up, start-up, shutdown, emergency, and abnormal operation, as well as steady-state operation. A section shall be devoted to isolation and restoration procedures to be followed when maintenance is required on the various major items of plant;
g) A full description of all construction and operational testing recommended to ensure proper preparation prior to operation of the equipment;
h) Comprehensive preventative maintenance schedules outlining each operation and the recommended period at which each item of maintenance should be carried out;
i) Complete installation and maintenance instructions, including details on preventative, breakdown and trouble-shooting diagnostics for known potential problems. These instructions shall be accompanied by illustrated equipment diagrams (assembly drawings) for use by maintenance personnel for parts selection and assembly instruction. I.e. Services Manuals, Workshop Manuals and Trouble Shooting Manuals. Instructions recommending the return of the equipment to the supplier for repair are not acceptable;
j) Recommendations to prevent deterioration during prolonged shutdown periods;
k) Assembly drawings showing relationship of equipment components (such as sectional views and exploded views of the equipment);
l) Settings of adjustable parameters, including setpoints of protective devices, such as TOL devices and protection relays;
m) Comprehensive equipment information, parts list (cross-referenced to assembly drawings). i.e. Parts Manuals;
n) Where the Equipment manufacturer offers several options for a certain part i.e. the actual part installed shall be stated in the instructions;
o) Nameplate information, Contact number and Manufacturer's contact address for each item of equipment and component part thereof;
p) The names and addresses of equipment manufacturers and suppliers together with the type, model reference, serial number, duty rating and the order number and date. The manufacturer's data shall include all necessary supplementary descriptions and instructions to ensure clarity.
q) List of all special maintenance tools required and supplied by the Contractor;
r) Listing of any programmable logic or other program including the ability to reinstall programming after a CPU/PC hard disk or PLC failure;
s) Software maintenance requirements;
t) Settings files for protection relays;
u) All test and verification results, and
v) As-constructed drawings and information.
The information shall be arranged in such a manner as to permit insertion of amendments and additional material. The instructions shall be cross-referenced for ease of use in maintenance and such reference number shall cross-reference to all drawing numbers, item numbers, part numbers and catalogue references necessary to ensuring identification and understanding of systems.

Before manuals officially enter circulation, the Designer is required to verify their contents and their suitability for use by Defence staff.

**Format**
As-constructed drawings shall comply with the Spatial Management Plan (SDMP) available from the web site at:


Provide metadata files of each drawing, compiled as described in the SDMP. Details of metafiles are also available from the IM website at:


Metadata files are necessary for plans to be loaded and catalogued in the National Spatial Information Management System (NSIMS).

Manuals shall include a Remote Data Module that describes any new or additional structures, plant or equipment. This is loaded directly into the Defence Estate Management System (DEMS). RDM’s are available from the Regional Information Manager through the Project Officer.

Provide an update of the existing ‘Master As-Constructed’ site plan of the base that incorporates the existing services and the new work. This update is to show the geographic detail described in the As-Constructed requirements including any redundant services left in situ, the location of capped services and any services that were removed.

The Operation and Maintenance Manuals shall be provided in both electronic and paper formats. The electronic format shall be suitable for inclusion on DEMS-FM; the paper format shall be suitable for the environment in which the manuals are used with all pages in plastic sleeves or similar.

The format of the manuals shall be generally as follows:

a) The page size shall be A4.

b) All pages shall have reinforced binding margins.

c) Preferred drawing size is A4. A3 drawing size may be used where clarity of drawing will be lost with reductions. Existing larger drawings to be bound in clear plastic packets.

d) Pages are to be numbered by section rather than consecutively so that additional pages can be readily inserted without affecting the existing page numbering.

e) New sections are to commence on new pages separated by tabulator dividers.
There should be provision for noting revisions on each page with amendment list in front of each manual.

- **Number of Copies and Submission Timing**
The Defence Project Director and Regional Manager Technical Services will advise the number of copies required, or a minimum of four copies (whichever the greater) of the manuals in each format, plus one additional copy in electronic format, shall be provided prior to handover of the installation to Defence.