Substation Design Instruction

Distribution substation
general details and
minimum requirements

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Document no. SDI 101
Amendment no. 5

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SDI 101 Distribution substation general details and minimum requirements

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1.0 PURPOSE

This is the key Standard to which all other design Standards in the distribution area are to refer.

This Standard covers the basic principles that need to be followed in all other distribution design standards.

2.0 SCOPE

This instruction is specifically relevant to Substation Design Instructions (SDI) 100 – 349 and also covers Mains Instructions, which are primarily associated with the design, construction, testing and commissioning of distribution equipment.

This instruction does not cover the general details and minimum requirements for on-site and construction, which are already covered in MCI 0005 and MCI 0006 and which should be referenced where necessary.

3.0 REFERENCES

- Company Policy 9.2.5 – Network Asset Design
- Company Policy 9.6.1 – Network Connection
- Company Policy 9.6.3 – Industrial/Commercial Distribution Design
- Company Policy 9.6.4 – Non-urban Distribution Design
- Company Policy 9.7.1 – Network Asset Construction
- Mains Construction Instruction (MCI) 0005 – Overhead Distribution Construction Standards Manual
- Substation Design Instructions (SDI) 100 to SDI 349
- Substation Maintenance Instruction (SMI) 113 – Distribution data entry asset structure and details
- Environmental Management Standard (EMS) EMS 0001 – Environmental impact assessment and environmental management plans
- EMS 0004 – Vegetation Management
- EMS 0007 – Waste Management
- EMS 0008 – Environmental Incident Response
- Electricity Supply Act 1995 (as amended)
- Work Health and Safety Act 2011
- ENA National Electricity Network safety code (Doc 01-2008)
- EC21- Procedures for risk management in the electricity distribution industry
- Service and installation rules of New South Wales
- Endeavour Energy Network Management Plan 2011-2013
- SPJ 4004 – Network Connection Contestable Works General Terms And Conditions
- AS62271.102:2005 HV switchgear and control gear - AC disconnectors and earthing switches.
- AS2067:2008 Switchgear assemblies and ancillary equipment for alternating voltages above 1kV.
4.0 DEFINITIONS AND ABBREVIATIONS

For the purpose of all Substation Design Instructions and any associated project, the following definitions apply:

AAAC  all aluminium alloy conductor
AAC  all aluminium conductor
ACSR  aluminium conductor steel reinforced
ABC  aerial bundled cable
ABS  air break switch
AUP  a person with technical knowledge or sufficient experience who has been approved and authorised in writing by the Company to perform the function requiring authorisation as described in Schedule 1 of Company Policy 9.1.3 - Authorisations. This definition is relevant to the terms “authorisation”, “authorise” and “authorised person”.

CBL  calculated breaking load - in relation to a conductor, means the calculated minimum breaking load determined in accordance with the relevant Australian Standard

CCT  covered conductor thick

Coastal  within 2km of the ocean, inlets and bays or salt spray affected areas

Contractor  shall mean an AUP in this instruction

Distribution  network  collection of assets (distribution lines, cables, substation and associated equipment) the purpose of which is to distribute power from zone substation to distribution substation which feed the low voltage network

Drawings  shall also include any drawings referenced to by that drawing or any drawing referenced to by a referenced drawing

EMS  Environmental Management Standard
HDPE  high density polyethylene
HV  high voltage
LV  low voltage
MCI  Mains Construction Instruction
MDI  Mains Design Instruction
MMI  Mains Maintenance Instruction

Network  Endeavour Energy’s electrical network of poles, wires, substations, and the like, by which electrical power is transmitted/distributed to its customers

NMSHVABC  Non-metallic screened high voltage aerial bundled cable
P-G clamp  parallel grooved clamp

Project  the work for which the AUP has been engaged to carry out, and may be defined in a standard, Project Definition or works order

Public land  Public land is defined as public roads and associated footpaths, or any other statutorily defined area where benefits for supply services, are vested to the Company. A public road is defined under the Roads Act 1993

PVC  poly-vinyl chloride

SCADA  Supervisory Control and Data Acquisition
SDI Substation Design Instruction

Site the location as indicated in a project or an area within the boundaries shown on any indicative general arrangement drawing which may be supplied in the project

Sub-transmission network collection of assets (transmission lines, cables, zone substation and associated equipment) the purpose of which is to distribute power in bulk from transmission substations to zone substations, which feed the distribution network, or a particular customer substation. Sub-transmission voltages in Endeavour Energy’s network are typically 132kV, 66kV and 33kV

S.W.E.R. single wire earth return overhead line system

Transmission system collection of assets (transmission lines, cables, zone substation and associated equipment), the purpose of which is to transmit power in bulk from Transgrid supply point to a sub-transmission substation. The transmission voltages in Endeavour Energy’s network is typically but not exclusively 132kV

UG underground

UG/OH underground to overhead, a pole used to connect underground cables to overhead mains

USL under slung link

Works the work necessary to complete the project as described in a Substation Design Instruction or project and associated drawings

XLPE cross linked polyethylene

4.1 Electrical switchgear assemblies

The following types of switchgear are used in distribution substations throughout Endeavour Energy:

- Circuit breakers
- Switches/switch disconnectors
- Isolators
- Fuses
- Fuse switch/fuse disconnector
- Switch fuse combination
- Switch fuse

Switchgear may not always comply with a definition in this document and the appropriate Substation Design Instruction or manufacturer’s data should be referred to for clarification.

Switchgear

A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated inter-connections, accessories, enclosures and supporting structures.

Indoor switchgear

Switchgear designed for use entirely indoor where the effects of atmospheric conditions are controlled.
Outdoor switchgear
Switchgear designed for use out of doors and capable of withstanding the full effects of the specified atmospheric conditions.

Circuit breakers (ref AS 60947.1:2004)
A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions such as those of short circuit.

Note: A circuit breaker is usually intended to operate infrequently, although some types are suitable for frequent operation.

Switch (ref AS 60947.1:2004)
A switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carry for a specified time currents under specified abnormal circuit conditions such as those of short circuit.

Note: A switch may be capable of making but not breaking short-circuit currents.

Disconnector (ref AS 60947.1:2004)
A mechanical switching device which, in the open position, complies with the requirements specified for the isolating function.

A disconnector is capable of opening and closing a circuit when negligible current is broken or made. Negligible current implies currents up to 0.5A such as the capacitance currents of bushings, busbars, connections, very short lengths of cables, and currents of voltage transformers or dividers.

A disconnector is capable of opening and closing a circuit when no significant change in the voltage across the terminals of each of the poles of the isolator occurs. No significant change of voltage refers to such applications as the bypassing of circuit breakers.

A disconnector is capable of carrying currents under normal circuit conditions and carrying for a specified time, currents under abnormal conditions such as those of short-circuit.

Fuse (ref AS 60947.1:2004)
A device that, by the fusion of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time.

Note: The fuse comprises all the parts that form the complete switching device.

A fuse element is that part of a fuse designed to melt when the fuse operates.

A fuse-link is that part of a fuse including the fuse element(s) which requires replacement by a new fuse-link after the fuse has operated and before the fuse is put back into service.

A current-limiting fuse is a fuse that, during and by its operation at its rated breaking capacity, limits the current to a value substantially lower than the peak value of the prospective current.
An expulsion fuse is a fuse in which the arc is extinguished by expulsion of gases produced by the arc. (An expulsion fuse does not exhibit significant current limiting features).

Switch - fuse combination (ref AS60947.1:2004)
A combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer.

*Note:* Also known as a fuse-switch combination.

5.0 ACTIONS

Standards must be complied with at all times. If a standard does not address a particular situation or is not practical to comply with the requirements of the standard, the matter must be brought to the attention of the Manager Network Engineering so that an approved solution can be developed. Any deviation from standards must be approved by the Manager Network Engineering.

This instruction shall be read in conjunction with all or any of the above listed distribution standards and with any associated project, which will define the works, required to be carried out by an AUP.

This instruction and any referenced instructions are designed to cover all the general requirements that need to be satisfied by an AUP to ensure the minimum standards and needs are achieved during the complete works of a project. The detailed design, construction, testing and commissioning requirements, outside those shown in the Distribution Instructions, are the responsibilities of the AUP.

Where a requirement is not covered by this Instruction (or the relevant MCI 0005 or MCI 0006) but is considered by the AUP to be essential to the correct functioning of this Instruction or project works then it shall be considered a requirement.

All works must be carried out by persons or organisations authorised to do so by Endeavour Energy and in accordance with the guidelines set by the NSW Trade and Investment - Energy.

5.1 Deviations from substation design instructions or project

Where it is desired by an AUP to deviate from the requirements of a Substation Design Instruction or project, written approval from the Substation Manager, Network Engineering must be obtained. Any request for deviations must be fully documented and contain substantiating proof of performance to the recommended Australian Standard or other standard as nominated in the Substation Design Instruction or project. Endeavour Energy reserves the right to decline the offer and insist on the nominated method or equipment as indicated in the Substation Design Instruction or project.

5.2 Underground services searches prior to commencement of works

Where any doubt exists in regard to the location of existing underground assets owned by Endeavour Energy, or any other utility, an underground records search must be conducted prior to the commencement of any underground works (including underboring and pole boring).

*The “Sydney One Call Service” (Dial before you dig) may be used to assist in the location of existing underground services. The is a free service and is available:*
5.3 Responsibility for works

In accordance with Endeavour Energy’s “General Terms and Conditions” documents the Accredited Service Provider (AUP) is responsible for the design of the electrical reticulation supply. As part of this responsibility the AUP must install and test all mains, substations and other equipment, and carry out all necessary excavation, backfilling and restoration associated with the installation of the network. Alternatively, the AUP may elect to have these works carried out by others, at the AUP’s expense.

5.4 AUP’s responsibility

The AUP will be responsible for all aspects of the design which is produced. Works must be designed strictly in accordance with Endeavour Energy’s design and construction standards.

5.5 Drawings for projects/works

After submission of the AUP’s engineering proposal, drawings, showing appropriate detail of conductor/cable routes, poles and any other equipment, shall be prepared by either Endeavour Energy or an external AUP. Prior to commencement of works, these drawings must be certified by Endeavour Energy.

5.6 Liaison with other utilities

It is the AUP’s responsibility to liaise with Endeavour Energy, accredited contract staff, and (with other utilities) the co-ordinators of other utilities prior to the commencement of works. When works commence the AUP must assume the role of co-ordinator of works. The AUP must ensure that all parties are kept advised of job progress, and are organised to carry out their works in sequence.

5.7 Local council requirements

The AUP must also satisfy the requirements of the relevant Local Council in respect of civil works associated with the provision of electricity supply to the subdivision.

5.8 Alignment/survey pegs

The AUP must correctly peg all easements and ensure that Chainage pegs are provided in the roadway indicating roadway centre line distances and finished road surface levels at the kerb invert, as per the AUP’s Engineering drawings.

The AUP must peg all subdivision property boundaries, and at pole locations as indicated on the project drawing. Offset recovery pegs must be installed at 90° to, and inside, the front property line. The offset recovery pegs are to have the offset dimension clearly marked on the upper part of the peg. In addition, a permanent mark must be placed on top of the kerb, in line with the offset recovery pegs and the property boundary pegs. Both the offset recovery pegs and the permanent mark on the kerb’ must be indicated by a readily identifiable colour. All re-work necessary because of incorrect pegging must be at the AUP’s expense.

All pegs must be clearly visible, readily identifiable and undisturbed after all construction works, in order to facilitate the accurate positioning and recording of poles, cables, associated substations and other assets.
5.9 Through traffic
Adequate provision must be made for any pedestrian or vehicular access, which might be impeded by any footway or roadway excavations.

5.10 Barriers
Where appropriate, the AUP must install and maintain effective barriers and lights around the work area at all times to serve as a warning to the public that works are in progress and to prevent injury to any person that may be in the work area.

5.11 Property damage
The AUP shall be responsible for any damage to Endeavour Energy's property, or third party property, as a result of activities under the control and/or supervision of the AUP.

The AUP must carry out searches to ascertain the location of all property or plant installed by Endeavour Energy, or any other utility, in the vicinity of the proposed subdivision. The AUP will be responsible for any damage to any works or property of any other utility or any individual, owing to activities under the control and/or supervision of the AUP.

5.12 Public safety and liability
The AUP will indemnify and hold Endeavour Energy harmless from all liabilities, claims, damages, suits and risks in respect of the works, their installations, supply, erection, testing and existence. Without limiting the generality of such indemnity the AUP will accept and acknowledge that injury or death to any person in respect of the Works (including open excavations) prior to the transfer of the works to Endeavour Energy will be the liability of the AUP and the AUP will indemnify Endeavour Energy against all such liability.

The AUP will be entirely responsible for the works until such works are transferred and accepted by Endeavour Energy and must make good any loss of damage suffered prior to this time.

The AUP shall comply with all requirements and standards that may be imposed by Workcover NSW on the AUP or would be imposed on a Principal, Agent, Contractor, Independent Contract Employer or Employee by Workcover NSW, whether under the Work Health and Safety Act or otherwise.

5.13 Easements
All network assets will be within public land. In situations where an asset needs to be installed in any location other than on public land or footpaths associated with public roads, an easement benefiting the Company, or legally equivalent status, must be granted to the Company to retain, maintain and operate all assets on that land. The easement needs also to cover maintenance of assets, such as underground cables, without any restrictions.

5.14 Network records
The locations of all Endeavour assets are kept in Endeavour Energy's official records databases. To enable Endeavour Energy's Officer to accurately determine these locations on site, it will be necessary to advise Endeavour Energy of equipment installation works taking place each day.
It is important that the location of all ducts and cables are recorded on the day of installation.

Numbering of poles, switches, substations, streetlights and the like, must be carried out in accordance with the requirements MCI 0005 and MCI 0006.

5.14.1 Quality of Materials and Workmanship

All materials used shall be new (unless the Project indicates or allows the use of other materials or approval is given by the Substation Manager, Network Engineering) and of a quality and class most suitable for working under the conditions specified without distortion, deterioration or setting up undue stresses on other equipment.

All work shall be neat and carried out in a tradesman like and professional manner to the approval of the Substation Manager, Network Engineering.

5.15 Workmanship

All works carried out in accordance with this instruction must be done in a tradesman like manner and must comply with the construction drawings provided in Endeavour Energy’s instructions and to the approval of Endeavour Energy.

5.16 Duty of care

The AUP, its employees, and including any subcontractor have a Duty of Care to the Public, other Service Providers and staff of Endeavour Energy during the course of the works. If a potential safety issue is identified it is the AUP’s responsibility to correct the problem or make the problem safe and repair it at a later date.

5.17 Environmental requirements

Reference should be made to Endeavour Energy’s Environmental Standards for preparation of environmental management plans, dust and noise suppression, protection of drains and waterways from silt and the like. Notwithstanding the requirements of these standards, the AUP must also comply with any other regulatory requirement regarding protection of the environment.

5.18 Design criteria overview

Each item of equipment, including supporting structures, foundations, general requirements such as electrical, mechanical and technological, shall be designed, specified, chosen, installed, tested and commissioned to meet the following requirements:

5.18.1 General

The AUP shall be fully responsible to ensure that all items of plant and equipment are supplied to be compatible with each other and the installation is complete in all respects including finishing, painting, labelling and the like.

5.18.2 Environmental

All equipment shall be suitable for the environment in which they will need to operate. Cubicles and similar enclosures shall be adequately ventilated to restrict condensation and where necessary anti condensation heaters shall be fitted with thermostatic control. Equipment shall be protected against corrosion. All constructional and operational noise and waste materials/runoff such as water and oil shall be controlled to meet local EPA and local council guidelines.
In coastal areas the design, construction and equipment used needs to be considered to achieve an effective life.

In bushfire or fire affected areas the use of non-combustible equipment such as non-flammable poles, stainless steel cubicles and the like shall be used where possible.

5.18.3 Insulation co-ordination
The design of plant and equipment shall be such that insulation co-ordination is provided between different items of plant such as transformers, surge arrestors and also between different components of items within a particular item of equipment.

5.18.4 Maintainability
All systems shall be designed to allow them to be maintained under normal switching criteria. All necessary tools and equipment, operations and maintenance manuals required for this purpose shall be provided by the AUP in adequate number of copies. All special tools shall be supplied by the AUP in two (2) sets.

5.18.5 Interchangeability
Similar items or parts shall be interchangeable as far as possible and practical without the need to modify the equipment with the use of tools and the like.

5.18.6 Substantiation of work
All designs are to be substantiated with engineering certificates, calculations and tests.

Qualifications of engineering staff assigned to this project shall be provided when requested.

5.19 Standards

5.19.1 Safety standards
The AUP, its employees, and including any subcontractors, shall abide by Endeavour Energy’s Electrical Safety Guidelines, and any amendments to these documents, throughout the duration of the works to be carried out as a result of any Substation Design Instruction or project.

5.19.2 Australian Standards
All design, construction, testing and commissioning shall be carried out in accordance with the relevant Australian Standards, Endeavour Energy Standards, manufacturers and suppliers’ literature and recommendations. Australian Standards are to be adopted in general. IEC or other international standards may be used if such standards are not less exacting than the corresponding Australian Standard. If other standards are to be used a copy of the relevant standard shall be forwarded to the Substation Manager, Network Engineering and approval given before it may be utilised in the project.

5.20 Data requirements
The following is to be entered by the AUP into Endeavour Energy’s approved database within 1 week of the construction work being completed. This data is to be entered at the lowest level of asset possible, reference is to be made to Substation Maintenance Instruction No SMI 113 for examples of the hierarchy.

- All new construction work for the following distribution substation equipment - All
distribution, isolating and voltage regulating substations and all high voltage switching stations.

- All equipment up-rates for distribution substation equipment.

The construction activity is to include the entering of any general data (refer to SMI 113) that has not been included into Endeavour Energy’s approved database, for the particular item on which the construction work is being performed. If other data not listed in the schedules is considered necessary, Endeavour Energy should be informed and the data collected. The parent/child hierarchy is shown in the schedules to facilitate the correct input of data.

Details of CT ratios, transformer tapping ranges and HV equipment voltages are to be entered into the ratio and voltage fields of Endeavour Energy’s approved database that can be accessed from the display menu.

The following specifies the voltage information to be included for each item.

Transformers: Primary, secondary and tertiary (if applicable) voltage of all available tapping ranges. It should be noted that CT ratios can be stored as details under the asset to facilitate data entry.

HV Switchgear: Primary voltage.

Reference is to be made to SMI 113 for examples of Endeavour Energy’s approved database data entry.

5.21 Equipment specification details

The following shall be provided for all equipment supplied by the AUP prior to submitting a tender for works as part of a Substation Design Instruction or project:

5.21.1 General requirements

All items of plant and equipment shall be of a proven design, manufacture and construction. AUPs shall provide details of performance, past orders, type tests, and other certificates from international organisations substantiating these details.

5.21.2 Technical specifications

Detailed technical specifications for major items of equipment shall generally be provided with projects or are available upon request to Endeavour Energy.

5.21.3 Spare parts

Documentation and guaranties shall be provided to ensure availability of spares parts for equipment supplied in a Project for a period of at least ten (10) years.

All manufacturers recommended spare parts required for operation and maintenance of the plant and equipment over the next five (5) years shall be supplied as part of the works of the project.

5.21.4 Warranty

The AUP shall provide a three (3) year warranty on all materials and workmanship from the date of delivery.
5.21.5 Purchase of major equipment

All items of equipment shall be purchased by the AUP and must conform to Endeavour Energy’s latest specifications and be approved by the Substation Manager, Network Engineering. If any items are to be provided by Endeavour Energy these items shall be listed in the project as "Free Issue" and the AUP must then use these items in the project.

5.21.6 Maintenance manuals

Five comprehensive sets of erection, operation and maintenance instructions each including a complete list of parts with serial numbers and copies of appropriate drawings shall be provided. These instructions shall include where necessary maintenance manuals of any operating mechanisms in "exploded" views. The instructions shall also include where necessary graphs showing circuit breaker operating time "speed" curves.

5.22 Approval process

Materials, other than those used by Endeavour Energy, may be used provided they have been approved for the particular application on the Endeavour Energy Network. Verification, in the form of an appropriate Endeavour Energy Product Approval number is required.

Endeavour Energy must approve all equipment prior to installation on the network. The technical specification for this equipment is either detailed in the equipment Design Instructions or can be obtained from Endeavour Energy separately. The approval process is detailed below.

Manufacturers will be required to supply the following:

- Completed schedules (where applicable)
- Detailed list of non-conformances/requested variations to specification
- All test results as detailed in the technical specification
- Detailed drawings of all components
- Viewing of identical equipment by Endeavour Energy
- Engineering approvals
- Information detailing compliance with the relevant Australian Standard

All test results shall be submitted in the form of detailed laboratory test reports from a recognised laboratory. Two (2) copies of all type, routine and special test reports for the tests stated in the equipment specifications and the associated standards are to be provided.

Where the supplier requests to omit certain tests, the supplier is to submit sufficient evidence to identify the design. If the equipment has been previously supplied to Endeavour Energy or has been extensively used in Australia, part or all of the above conditions may be waivered. A statement detailing past usage and performance complete with a list of similar equipment that has been supplied in Australia, giving dates of placing in service is to be provided.

The supplier shall provide one (1) electronic copy in AutoCAD R12 format or two (2) paper copies of drawings of all major equipment including those shown below. All relevant manufacturers data shall also be provided.

- General arrangement drawing of the complete item showing the location of all major components, critical /overall dimensions and mass.
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- Diagram and rating plate drawings.
- Drawings or data which may be necessary to install, maintain, dismantle, reassemble or adjust all parts of each of the major components and to repair or replace all parts particularly liable to wear and failure.

Endeavour Energy shall, within a reasonable time, either allow the design to be used or indicate where it desires alterations. All titles, legends and the like shall be in English.

In addition to above the following must be approved for each of the major components.

(a) One (1) copy of type and routine tests in accordance with the appropriate Standard’s, Inspection and Tests clause.
(b) Details of fault current indicators, testing and earthing attachments.

Endeavour Energy reserves the right to have final say on the acceptance or declining of any equipment offered as major equipment.

Endeavour Energy reserves the right to withdraw approval at any time. The reasons for this may include – performance of equipment and implementation of new technology.

6.0 AUTHORITIES AND RESPONSIBILITIES

The Chief Engineer has the authority and responsibility for approving this instruction and approving variations to the requirements of this instruction.

The Manager Network Engineering has the authority and responsibility for endorsing and recommending changes and revisions to this instruction.

The Substations Manager, Network Engineering shall be responsible for revising and updating this instruction in accordance with Company Policy and Procedures.

Regional Managers shall be responsible for ensuring that all designs carried out by Regional employees conform to the requirements of this instruction.

The Manager Network Connections shall be responsible for ensuring that all designs carried out by Level 3 AUPs conform to the requirements of this instruction.

It will be the AUPs’s responsibility to:
- ensure all new or modified assets or network are designed and constructed to the requirements of these standards; and
- ensure that the latest issue of any instruction or drawing relevant to or listed in this manual is available and used during the design of any project.

7.0 DOCUMENT CONTROL

Documentation content coordinator: Substations Manager, Network Engineering
Documentation process coordinator: Branch Process Coordinator