

NP001.7

Reliability Criteria for Distribution Networks

This document is extracted from Network Policy NP 001, Design and Construction of Network Assets.

Other documents in this series include:

- NP001.1 Design and Construction of Network Assets – General Requirements
- NP001.2 General Specification for Underground Electrical Reticulation
- NP001.3 General Specification for Overhead Electrical Reticulation
- NP001.4 General Specification for Overhead Rural Residential Subdivisions
- NP001.5 General Specification for Overhead Commercial and Industrial Subdivisions
- NP001.6 General Specification for URD Subdivisions
- NP001.8 Handover Documentation
- NP001.9 Conditions of Supply to Large Customers
- NP001.10 Documentation Requirements

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2. Scope

This document sets out the basic philosophy of planning for reliability in a distribution network, including distribution substation design. It should be read in conjunction with the publications *Power Networks Planning Criteria* and NP001.9 *Conditions of Supply to Large Customers*.

3. Reliability Criteria

3.1 Planning Criteria

Power and Water is required to publish Planning Criteria to establish the basis of capital investment in the network. The Criteria set out the philosophy of 'backup' provision in the event of equipment faults. This philosophy relates investment to the level of security required at various parts of the network.

The philosophy at the distribution level is based on modified 'n-1' criteria.

3.2 Distribution Reliability Overview

Fundamentally this means that, in the event of any single failure of equipment, supply should be quickly restored – either by switching around the fault, or by the use of mobile generators.

For urban areas, this can be economically achieved by the use of interconnections, loops, etc. Large urban customers typically have large numbers of people living or working in buildings, and loss of supply can have a major social or safety impact. Some industrial customers have processes that are highly intolerant to interruptions, while loss of supply to hospitals, airports, etc, can have significant safety implications.

For rural areas, because lines are very long, it is often uneconomic to duplicate supply. However, such systems are overhead, and faults can be found and repaired relatively quickly. Rural customers tend to be smaller with fewer social or safety implications associated with interruptions. Mobile generators can be targeted at customers where such implications exist.

4. High Voltage Distribution Lines

4.1 Urban Areas

Generally, all HV lines in urban areas are to be looped or tied so that individual faults may be switched around. Operationally this means that spare capacity must be available in the HV system so that load can be transferred to other parts of the system without overloading them.

The only exception to this is cable supplying a single individual substation that can be supplied by a mobile generator. This generally means 1000kVA in Darwin, 500kVA in Alice Springs, and 300kVA in Tennant Creek and Katherine.

In such cases, the customer may be given the option of alternate supply. Where the Reliability Criteria do not require duplication of supply, the customer will be required to bear the full cost of any assets needed to make alternative supply available.

Where the Reliability Criteria require an alternate supply to be made available, the cost of this will be included in the supply negotiations in accordance with the *Distribution System Extension Policy*.

4.2 Rural Areas

Where economic to do so, HV supply to rural subdivisions is to be looped so that faults can be switched around. Air or Gas-Break Switches (GBSs/ABSs), links, etc, shall be installed for this purpose.

Where it is not economic to do this, radial lines may be used.

The layout of any subdivision should be discussed with Power and Water prior to making any commitments. Power and Water will advise requirements at this time.

Customers with substations supplied by HV underground cable shall generally be treated as for urban areas, with cable duplication in cases where the substation is larger than local mobile generators.

5. Distribution Substations

5.1 Urban Residential

Generally, urban residential substations will be backed up through the LV system as per NP001.6 *General Specification for URD Subdivisions*. HV supply will be looped through each substation, with the exception of radial runs to substations that may be supplied by mobile generator.

5.2 Urban Industrial – Street Substations

Most industrial customers are supplied from pole substations. While it is not practicable, as a rule, to fully back up such substations through the LV system,

generally there should be robust ties to neighbouring substations to provide maximum capability. This requires that the LV system should be the equivalent of at least 200mm² Al. along the shortest route between each substation.

5.3 Urban Industrial – Customer Substations

Substations located on the customer's premises are usually supplied by overhead HV line, which can be repaired quickly in the event of a fault. Where the customer opts for a package or indoor substation supplied by HV underground cable, the customer should be offered backup options. Where the load may be supplied by local mobile generator, no options need be offered. However, where the load is greater than this, the customer should be advised to install alternative HV cables at the full cost of the customer.

For loads too large to be supplied by mobile generator, the customer should also consider a multi transformer substation.

For loads capable of being supplied by mobile generator, the option of a LV tie back into the street distribution system should also be offered at full cost, as this provides a quick restoration of supply. For customers with sensitive processes (e.g., glass or plastic moulding), Power and Water can discuss automatic or customer controlled changeover of supplies, with or without load shedding arrangements.

5.4 Urban Commercial – Non CBD

Includes local shopping centres, schools, supermarkets and the like. Unlike industrial customers, these feature large numbers of people using the premises day or night.

Generally, substations capable of being supplied by mobile generators may be single transformer supplied by single HV cables. Some LV backup should be provided where economic to do so.

Where load exceeds mobile generator size, alternative HV supply and multi-transformer substations should be provided. Such installations shall be negotiated in accordance with the *Distribution System Extension Policy*.

5.5 Urban Commercial – CBD

Refers to areas containing high rise office accommodation, large hotels, major supermarkets and the like. In Darwin the Casuarina Square and Palmerston shopping centres would be classified under this section, as well as the Darwin CBD.

Generally, HV supply to each substation will be looped or duplicated. Substations shall have multiple transformers, capable of supplying the whole load in the event of loss of one transformer. Smaller transformers may be used where substantial backup is provided by the LV system, or for customers with automated load shedding of non-essential load.

For customers deemed 'essential' by Power and Water, full automatic isolation of individual cables or transformers may be specified.

These arrangements will be funded as per the terms set out in the *Distribution*

System Extension Policy.

5.6 Arrangements for Multiple Transformer Substations

Multiple transformer substations are confined to chamber or ground types.

General arrangements shall be in accordance with the Standards Manual and the publication NP001.9 *Conditions of Supply to Large Customers*.

Each transformer shall be protected by a high voltage circuit breaker. Low voltage protection shall consist of a circuit breaker for each transformer, set to trip at the nominal rating of the transformer. It shall be capable of adjustment by Power and Water staff to higher values during emergency conditions. Generally low voltage circuit breakers should have a rating at least 10% more than the nominal transformer rating.

Customers' switchboards shall normally be arranged with a bus section for each transformer. Castell key systems will normally be employed to prevent paralleling of the transformers; this is to prevent the second transformer from tripping on overload when the first transformer trips for any reason.

However, Power and Water will consider parallel arrangements subject to the following:

- the switchboard is capable of withstanding the prospective fault level;
- automatic load shedding of non-essential load is employed;
- each transformer is large enough to cope with the full load of the installation; and
- the customer's circuit breakers are capable of being locked in position to enable Power and Water staff to work on Power and Water's equipment.

For chamber substations, Power and Water will consider options of solid insulation to limit damage in the event of a fire. These options are subject to negotiations, and would involve additional cost to the customer.

Every large substation design shall be discussed with, and approved, by Power and Water before work commences.

5.7 Rural Residential

Generally, Air or Gas-Break Switches need to be located at strategic locations (e.g., major tee-offs), and about every six distribution substations.

Where available, substations will be backed up on the LV system from neighbouring substations.

5.8 Rural Commercial/Industrial

Substations supplying industrial or commercial customers shall be treated as for urban substations, except where it would be uneconomic to achieve alternative HV supply.