ElectraNet

Substation Lightning Protection

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This functional requirements document is in line with the organisation's 1-11-ACS-11 Substation Lightning Protection Asset Class Strategy

Contents

1. Definitions

In this document the following words and expressions will have the following meanings:

Item	Meaning
3D	Three Dimensional.
AS	Australian Standard, as publication by Standards Australia (Standards Association of Australia).
CAD	Computer Aided Design.
CDEGS	Current Distribution Electromagnetic Interference Grounding Soil Structure Analysis software design package.
Contractor	A contractor engaged by ElectraNet or a Customer (including a third party IUSA provider engaged by a Customer or any contractor engaged by such third party IUSA provider) to perform any design, construction or related services in relation to assets or infrastructure which are connected, or to be connected, to ElectraNet's transmission network
Customer	A party who wants to establish or modify a connection to ElectraNet's transmission network but does not include a third party IUSA provider
ITPs	Inspection Test Plans.
NER	National Electricity Rules.
OHEW	Over Head Earth Wire.
PVC	Polyvinyl chloride.
SAP	Systems, Applications and Products, a software application used by ElectraNet for asset management functions.
SPD	Surge Protection Device.
SPF	Smart Plant Foundation, a system for managing ElectraNet technical standards, documents and drawings
Standard Drawing	A drawing developed by ElectraNet as a complete design to be used for construction. Standard Drawings are not intended to be revised or renumbered.
Strike Distance	The length of the final jump between the downward stepped leader and the grounded structure, as the electric field in this gap exceeds the electrical breakdown strength.
Stroke Current	The magnitude of current of the lightning stroke upon termination.
Template Drawing	A drawing developed by ElectraNet as the basis for design. Template Drawings are intended to be revised and renumbered as required to complete the design.

Item	Meaning
third party IUSA	Has the same meaning as defined in the National Electricity Rules

2. Purpose and Scope

This document describes the functional requirements for substation lightning protection systems and the integration of lightning protection systems into a substation.

The design scope of works includes the provision of a lightning protection design report, the creation of applicable design drawings to allow construction to proceed, and the supply of a software design model.

The construction scope of work includes the procurement, installation and commissioning of the lighting protection system such as lightning masts and associated earth stakes, overhead earth wires, down conductors, fittings and connections to the substation earthing system.

3. Referenced Documents

The table below lists applicable legislations, standards, referenced documents:

Legislation	
SAEA	Electricity Act 1996 (SA)
SAER	South Australia Electricity (General) Regulations 2012 (SA) under the SAEA
NER	National Electricity Rules
ETC	Electricity Transmission Code TC/08
SAA HB59:1994	Ergonomics - The human factor A practical approach to work systems design
International Standards	
IEEE Std 998:2012	Guide for Direct Stroke Shielding of Substations
IEEE Std 837:2014	Standard for qualifying permanent connections used in substation grounding.
AS 2067 :2016	Substations and high voltage installations exceeding 1 kV a.c.

4. Lightning Protection

4.1 General

The lightning protection system for the site must comply with IEEE 998.

4.2 Design and Construction

4.2.1 Introduction

4.2.1.1 Substation lightning protection systems must protect substations (plant equipment and buildings) from harmful effects of direct lighting strikes.

4.2.1.2 These systems must protect the substation from thermal, mechanical and electrical effects caused by lighting discharges.

4.2.1.3 Direct lighting strikes cannot be prevented however can be intercepted and conducted harmlessly to ground through the earthing systems.

4.2.2 Study

4.2.2.1 The Contractor must undertake a lightning protection assessment of the site unless the site specific documentation indicates it is not required.

4.2.2.2 ElectraNet will make available existing technical information of the site available to the Contractor for the purposes of a lighting protection study. The information may include:

a) LIWL for all equipment at all voltages;

b) Type of Phase Conductor;

c) Conductor configuration;

d) Outer Diameter of the Conductor;

e) Attachment height of the Conductor;

f) Attachment height of OHEW (for gantry applications);

g) Sag on the conductor (flexible or strung bus);

h) Sag on shield wire; and

i) Existing substation information (for Brownfield applications, if required).

4.2.2.3 The Contractor must bring to the attention of ElectraNet any missing technical information prior to undertaking the design. Where information is missing the Contractor must make an allowance in the submission for any back calculations or proposed values which must be approved by ElectraNet.

4.2.2.4 The lightning protection design must consider the operation, maintenance and eventual decommissioning of the system to maximise safety, minimise damage to assets and minimise outage times during the life of the asset.

4.2.2.5 The preferred method for assessing the lightning protection coverage is by providing a 3D model of the substation either in CAD or in CDEGS SESShield tool.

4.2.2.6 The allowable separation distance between shield wires and masts adjacent and diagonally must be no more than 75 % of the calculated maximum value as per IEEE 998 requirements.

4.2.2.7 The lightning protection must be developed in conjunction with the insulation coordination considerations to correctly identify the Stroke Current to be used for a lightning strike applied directly to the equipment or the busbar in the substation.

4.2.2.8 The study must culminate in a design report where Strike Distance calculations, 3D model of the substation and a protection coverage plan are provided to ElectraNet for review.

4.2.3 Requirements

4.2.3.1 Protection of substation equipment, including buildings, must be achieved through the provision of an effective protection system for the interception of lightning discharge and the safe dissipation to the ground.

4.2.3.2 The same functional requirements apply for both greenfield and brownfield applications.

4.2.3.3 The lightning protection design must maximise safety, minimise damage to assets and minimise outage times in the unplanned situation that the protection system should fail.

4.2.3.4 The lightning protection system must discharge currents safely without exceeding design limits for thermal, thermo-mechanical and electromechanical stresses.

4.2.3.5 The substation including building, primary plant and connected infrastructure must be protected against lightning according to IEEE 998 based on the rolling sphere method with effective shielding determined based on the calculated maximum Stroke Current and Strike Distance.

4.2.3.6 The lightning protection must be provided as a combination of lightning protective devices such as lightning masts and OHEW coverage, connected to an earthing system. The use of telecommunications structures as part of a lightning system is permitted where they are present.

4.2.3.7 OHEW must be connected to poles or gantries, which must be bonded to the primary earthing system within the substation by a minimum of two connections. The OHEW must be attached to pole or gantries using ElectraNet Standard Drawings.

4.2.3.8 Lightning masts must be installed in the yard as dictated by the lightning protection design and connected to the earth grid via a dedicated earth rod connected to the earth grid.

4.2.3.9 Down conductors must be a minimum of 70 mm2 and be PVC green/yellow insulated and must be fitted for lightning mast and telecommunication structure applications. Down conductors are not required where OHEW are used.

4.2.3.10 Connectors must be in accordance with IEEE 837.

4.2.3.11 The choice of protection devices must be determined by the design which must consider the location within the substation of other grounded structures such as communication towers and gantry systems or pole supporting earth wires.

4.2.3.12 OHEW is ElectraNet's preferred lightning protection device. However, continuous spanning by OHEWs of two separate busbars, two separate feeders, two separate transformers, or two separate capacitor bank bays is not acceptable. The potential damage to high risk equipment (high replacement cost or lead time) or effect on continuity to supply from the failure of any protective device, including masts, must be minimised.

4.2.3.13 Placement of lightning masts must not obstruct electrical clearances and maintenance access to other equipment within the substation.

4.2.3.14 The lightning protection system must always be available except for planned maintenance activities.

4.2.3.15 The design of lightning masts must take into account site specific conditions such as expected wind speeds and gusting effects to ensure that fatigue failures do not occur. If necessary, "dampening conductors" must be installed inside the lightning masts

4.2.3.16 The lighting protection system must utilise materials that are safe for the environment.

4.2.3.17 Lighting poles must not be used as lightning protection devices. In the event that a lighting pole falls within an unprotected zone, direction from ElectraNet must be sought as to whether further protection is required or not. Being a metallic earthed object it may be deemed sacrificial if hit directly by lightning. However, to protect the secondary wiring appropriate Surge Protection Devices (SPDs) must be installed, where applicable.

4.2.3.18 The lightning protection system must be installed and brought into service through the use of approved ITPs.

4.3 Data Capture Requirements

4.3.1.1 The following information must be provided and stored in SAP on the lighting protection system:

a) functional location, number and physical parameters of the lightning masts;

b) functional location, number and physical parameters of the structures supporting the OHEWs; and

c) each structure, i.e. lightning mast, gantry structure or pole supporting an OHEW, and telecommunications tower must have labels attached to them identifying the functional location as well as providing a lace to apply a barcode.

4.3.1.2 The design report, software model and associated design drawings, reflecting the as-built status of the lightning protection system will be stored as separate objects under the same placeholder in ElectraNet's SPF electronic system.

4.3.1.3 The Contractor must provide a formal as built CAD drawing showing the lightning protection coverage plan.

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