

IEEE Trial-Use Guide for Development of Specification for Turnkey Substation Projects

Sponsor

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Abstract: The technical requirements to engineer, design, specify, fabricate, manufacture, furnish, install, test, commission, and provide as-built documents for air-insulated substations are covered. This guide investigates the methods, practices, and requirements of both users and suppliers in order to promogate a systematic and coordinated approach for development of specifications for turn-key substation projects.

Keywords: substations, turnkey substations

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Introduction

(This introduction is not part of IEEE Std 1267-1999, IEEE Guide for Development of Specification for Turnkey Substation Projects.)

This guide is issued to aid users in developing and preparing specifications for air-insulated turnkey substation projects; its intent is advisory. The guide covers parameters to be supplied by the Purchaser or the Purchaser's engineer so that a substation project can be engineered, designed, specified, fabricated, manufactured, furnished, installed, tested, commissioned, and warranted by a turnkey Contractor. Permits and site preparation requirements shall be mutually agreed to by the Purchaser and the Contractor. Normally, services for initial development of the project and permitting shall be part of the turnkey services provided by the Contractor.

The significance of the word *turnkey* is to be understood to be inclusive of all initial development, engineering, procurement, construction, and commissioning. It also requires that the Contractor provides a single, integral system warranty and incorporates project and scope risk.

Nothing in this guide shall prevent the Purchaser from providing additional requirements and oversight for the Contractor or the Contractor's work. Such involvement and the degree should be spelled out in the specification.

Proposal data, noted in 3.4, which shall be completed by each bidding turnkey Contractor, are provided in order to elicit uniform responses and to facilitate technical proposal evaluation.

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IEEE Guide for Development of Specification for Turnkey Substation Projects

1. Overview

This guide covers the technical requirements to engineer, design, specify, fabricate, manufacture, furnish, install, test, commission, and provide as-built documents for air-insulated substations.

The Contractor should furnish all equipment, materials, and services as specified by the Purchaser and as indicated in the one-line diagram and the contract documents.

The Purchaser is responsible for the project data and information for use by the Contractor in the proposal. If either party supplies technical data, that party is responsible for the data accuracy.

1.1 Scope

The scope of this guide is to investigate the methods, practices, and requirements of both users and suppliers, and to promogate a systematic and coordinated approach for development of specifications for turnkey substation projects.

1.2 Purpose

The purpose of this guide is to develop, for producers and users, methods and procedures for formulating complete specifications for turnkey substations or projects.

1.3 Contractor qualification/certification

All designs, calculations, and drawings should conform to applicable, latest approved standards. If required, licensed professional engineers of the state or province where the site is located should certify calculations and drawings. Contractor experience, resources, financial capability, management, and any other qualifying criterion set by the Purchaser should be considered.

1.4 Site data

The Purchaser should provide the environmental site data shown in Table 1.

Table 1—Site data

Type of data	Measurement
Installation	Outdoor or indoor
Elevation above sea level	m (ft)
Maximum ambient temperature	°C (°F)
Minimum ambient temperature	°C (°F)
Relative humidity	%
Maximum wind velocity	km/h (mph)
Maximum ice loading	mm (in)
Seismic condition	g/zone
Air quality	—
Special environmental considerations	—
Rainfall	mm (in) accumulated in 1 h and 24 h
Snowfall	mm (in) height of maximum drifts and cross depth
Frost depth	m (ft)
Keraunic level	Thunderstorm days per year
Soil resistivity (if known)	Ω -m
Grounding parameters	—
Fault current	kA (3 $\emptyset$ and L-G)
Fault clearing time for primary and backup protection devices	s
Zoning restrictions	—
Setback required	m (ft)
Maximum permissible noise level	dB
Truck access required for mobile transformer	m (ft)
Oil spill containment required for transformer	—
Grading and landscaping required	—
Site security considerations	—
Zoning restrictions	—
Height restrictions	m (ft)
Wetlands	—

The Purchaser should provide wind and ice loading conditions. Special attention should be given to the simultaneous application of various loading criteria, which may include the seismic condition.

The Contractor should be able to rely on this information to prepare a bid without independent verification.

1.5 Equipment and services furnished by the Purchaser

Where the Purchaser provides equipment and services, a clear understanding on division of responsibility should be reached between the Contractor and the Purchaser during the life of the project to avoid any conflict about the scope of the work. This may include the following:

- a) List of engineering services provided by the Purchaser or the Purchaser's engineer;
- b) List of any equipment supplied by the Purchaser;
- c) All pertinent technical data on the equipment provided by the Purchaser, including drawings and data sheets;
- d) Site development, including access roads and railroad crossings;
- e) List of permits, licenses, and approvals from local, state or province, and federal agencies. The Purchaser may require permitting support;
- f) List of the Purchaser's field supervision, inspection, and audit personnel;
- g) Description of interface with existing facilities, including outage coordination on supervisory control and data acquisition (SCADA), ac/dc station service supplies, interconnecting cables, ground grid, telecommunication facilities, transmission line(s), and water and sewer supplies;
- h) Potential staging areas, where applicable.

1.6 Special tools furnished by the turnkey Contractor

If specified, any special tools, lifting devices, or jigs required for the maintenance and operation of the facility should be provided by the Contractor and assigned to the Purchaser. If these special devices are needed during the installation stage, an agreement between the Purchaser and the Contractor should govern the use of these devices.

1.7 Purchaser terms and conditions

The Purchaser's commercial terms and conditions are beyond the scope of this guide. These are to be considered by the Purchaser and the Contractor on an individual basis.

2. References

This guide should be used in conjunction with the applicable standards, some of which are listed in Annex B. If the guides or standards are superseded by an approved revision, the latest revision shall apply.

In the event of conflict between the referenced standards, the drawings of the Purchaser and their specifications, or between standards issued by various authorities, such as local, state or provincial, federal, or other regulatory government agencies, the Contractor shall notify the Purchaser and secure written clarification as to what is acceptable before proceeding with the work.

The Contractor shall propose recommendations for materials or components when no standards are available.

3. General requirements

3.1 General description

The substation electrical layout and equipment rating should be based on the one-line diagram furnished by the Purchaser. The Purchaser should also provide the electrical ratings and any special requirements, such as spatial limitations or protective measures, in particularly harsh operating environments.

The equipment should be capable of withstanding specified outdoor environmental conditions, as well as specified electrical, mechanical, and thermal ratings.

Optimized arrangements are required to provide easy access for operation, maintenance, and repair, and to facilitate future additions as described in the specifications.

3.2 Optional additional equipment and services by the Contractor

If required, the Contractor should include the following:

- a) Insulation coordination study
- b) Seismic study
- c) Grounding study
- d) Shielding and lightning protection
- e) Spare parts and special tools
- f) High-voltage test equipment, if required by the Purchaser
- g) Electromagnetic field (EMF) study
- h) Hazardous materials identification
- i) Site contamination study
- j) Hydrology study
- k) Relay setting tables
- l) Short circuit study
- m) Protection relay coordination study
- n) Load flow study
- o) Overhead conductor sag chart
- p) Geotechnical report including environmental considerations
- q) Wind and/or ice load study
- r) Noise level study

3.3 Miscellaneous equipment and services by the Contractor

The Contractor's scope of work should include, but not be limited to, the following items required for a complete installation:

- a) All bus fittings, support insulators, and supporting structures necessary to operate and maintain all equipment.
- b) All concrete foundations should include anchor bolts, steel reinforcing beams, and other associated parts. Foundation designs should take into account soil conditions, thermal expansion and contraction, equipment loads, and attachment points. Foundation layout should meet required electrical clearances.
- c) Flexible connections for all equipment supplied should be provided as required, ensuring continuity of service during thermal expansion or contraction, vibration, and seismic activities.
- d) Control, metering, monitoring, protection, indication systems, annunciators, cathode-ray tubes (CRTs), etc., including local control cabinets, should be provided as specified.
- e) Ground grid and groundwire terminations for connection to the ground grid from structures and equipment.
- f) Wiring and means for wiring between individual items of Contractor (or Purchaser) furnished equipment.
- g) Nameplates for each piece of equipment, as specified by the Purchaser.
- h) Sulfur hexafluoride (SF_6) gas supply system, including density monitors and sufficient quantity of SF_6 gas for initial filling of circuit breakers, if applicable.
- i) External surface preparation and coating, if specified.
- j) If equipment is derated due to altitude and/or ambient temperature conditions, the Purchaser must be advised of the new rating in the proposal.
- k) Sufficient quantity of transformer oil, if shipped separately. The Contractor should vacuum fill the transformer, if shipped without oil.
- l) Fire protection equipment/structures.

3.4 Proposal data by the Contractor

If required, the Contractor shall include the following:

- a) Preliminary project schedule with starting and completion dates for each required activity.
- b) Contractor's previous experience, including specific experience on similar projects, shall be provided. Information shall include manpower, equipment, key personnel resumes, reference lists with contact person, and safety records of Contractor.
- c) Complete data sheets for all major equipment shall be provided. Separate data sheets should be provided for each alternative.
- d) Listing of exceptions to, and deviations from, the specifications shall be provided. All exceptions should be clearly and separately itemized.
- e) If Contractor uses subcontractor(s), all relevant data requirements applicable to the Contractor will also apply to the subcontractor.

3.5 Other considerations

The Contractor should be responsible for inspecting and receiving equipment and materials delivered to the work site to ensure that the equipment and materials are undamaged and are in compliance with specifications. It should be the responsibility of the Contractor to protect the materials and equipment against damage and theft until the Purchaser accepts the project.

Annex A

(informative)

Design considerations

A.1 Project scope

The Purchaser should provide the following information to the Contractor:

- a) The scope of the project
 - 1) Substation one-line diagram—for the initial and ultimate stage, including metering, protection, telemetering requirements, and electrical parameters
 - 2) Number, location, and technical data of transmission/distribution lines (including underground)
 - 3) Phase rotation diagram
 - 4) Details of existing facilities, including underground utilities such as gas, water, and cables
 - 5) Geography of the site (e.g., boundary and topographical surveys, and soil borings)
 - 6) Soil resistivity measurements
- b) Site constraints
- c) A copy of the Purchaser's applicable standards, so that the Contractor can produce a design that will provide reliable integration into the Purchaser's system
- d) Regulatory requirements

A.2 Land use and environmental considerations

The Purchaser may use the following list of biophysical and land-use study categories as a guide to determine the extent of the environmental effort required for the project. The extent of work required depends on the size and location of the project:

- a) Terrain
 - 1) Surface and bedrock geology
 - 2) Soils
 - 3) Slope stability and erosion potential
 - 4) Permafrost
- b) Vegetation
 - 1) Vegetation types
 - 2) Rare and endangered plants
 - 3) Revegetation potential
- c) Agriculture
 - 1) Soils and drainage
 - 2) Forage and horticulture