

IEEE Guide to Specifications for Gas-Insulated, Electric Power Substation Equipment

Sponsor
**Substations Committee
of the
IEEE Power Engineering Society**

Approved 29 October 2002
American National Standards Institute

Reaffirmed 12 June 2008
Approved 19 September 1996
IEEE Standards Board

Abstract: Technical requirements for the design, fabrication, testing, and installation of a gas-insulated substation (GIS) are provided. Parameters to be supplied by the purchaser and the technical requirements for the design, fabrication, testing, and installation to be furnished by the manufacturer are discussed. Environmental conditions, general and specific equipment requirements, and a proposal data sheet form are provided to aid the user.

Keywords: gas-insulated substations, GIS, GIS design, GIS equipment, GIS installation

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345 East 47th Street, New York, NY 10017-2394, USA
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ISBN 1-55937-896-4

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Introduction

(This introduction is not part of IEEE Std C37.123-1996, IEEE Guide to Specifications for Gas-Insulated, Electric Power Substation Equipment.)

This updated guide is issued to aid users in developing and preparing specifications for gas-insulated substations and equipment; its intent is advisory. The guide covers parameters to be supplied by the user and technical requirements for the design, fabrication, testing, and installation to be furnished by the supplier. The user should revise any paragraph as appropriate, delete any paragraph that does not apply to his or her needs, and incorporate any details to make the specification conform to his or her standard practices and requirements.

Proposal data, provided in clause 7, should be completed by the user and by each bidding supplier in order to elicit uniform answers from all the providers and to facilitate technical proposal evaluation. The form in annex A is a simple way for the user to provide to the GIS supplier the principal constraining information that defines the GIS required. The form should be sent to the suppliers early in the planning cycle to obtain information regarding availability of equipment, typical physical arrangements and budget prices. The form does not need to have 'specification' attached. However, users are encouraged to ask suppliers to review the specification to be used in preliminary form and submit comments during the planning stage of the project.

The following is a list of participants in the effort of the IEEE Project C37.123 Working Group K6 on GIS Specifications of the Gas-Insulated Substations Subcommittee of the IEEE Substations Committee.

R. Matulic, Chair

A. Arora
P. C. Bolin
D. Charbonnet
R. Crowdis
J-M. Delcoustal

N. Fujimoto
J. Gustin
W. E. Howell
R. Jeanjean
R. A. Jones
H. Koch

A. A. Leibold
J. Luiz
K. Pettersson
H. C. Thakar
J. A. Yoder

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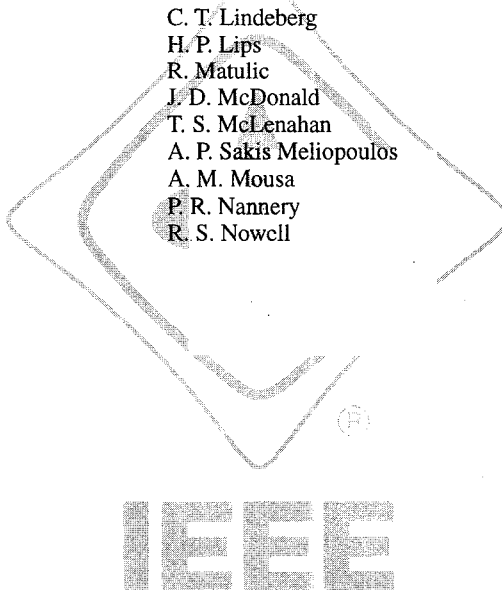
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A. Mickevicius
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K. Pettersson
D. J. Poole
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R. Whiteside
J. A. Yoder

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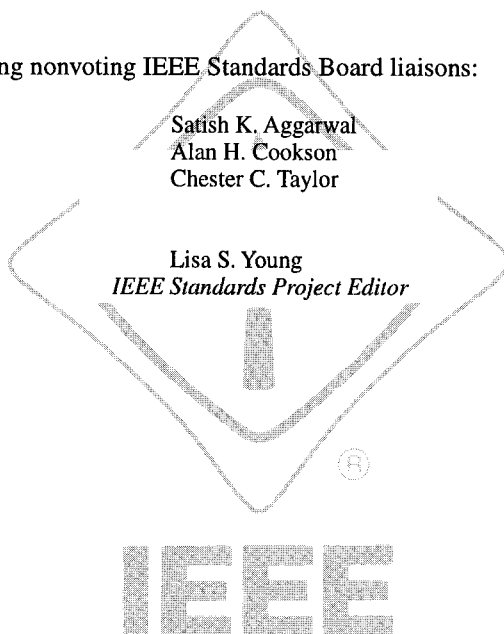
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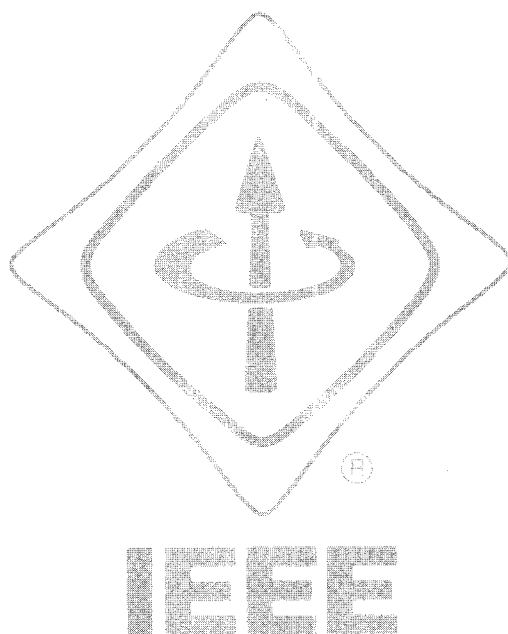
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IEEE Guide to Specifications for Gas-Insulated, Electric Power Substation Equipment

1. Overview

1.1 Scope

This guide covers the technical requirements for the design, fabrication, testing, installation, and in-service performance of a gas-insulated substation (GIS).

The supplier should furnish all equipment and material necessary to provide the complete GIS as shown on the functional one-line diagram, which may consist of circuit breakers (CB), disconnect switches (DS), maintenance ground switches (MGS), fast-acting ground switches (FGS), voltage transformers (VT), current transformers (CT), SF₆-to-air bushings, SF₆-to-cable termination, buses, cable termination enclosures, transformer or reactor bushing enclosures, enclosed surge arresters, elbows, bellows, controls, cables for control, protection and metering, density monitors, platforms, special tools, and SF₆ gas for initial filling. All equipment and material shall be prefabricated, factory assembled, tested, and shipped in the largest practical assemblies.

Assembled equipment should be capable of withstanding electrical, mechanical, and thermal ratings of the specified system. All joints and connections should be able to withstand the forces of expansion, vibration, contraction, and specified seismic requirements without deformation, malfunction, or leakage. Equipment shall be capable of withstanding the specified outdoor or indoor environment.

Optimized arrangements, shown in annex A, are required to reduce installation time, provide ease of operation, minimize maintenance and repair prices, and facilitate future additions as described in the specifications. The user should identify space or area limitations for the GIS, driveway access, and any overhead clearance restrictions. Final arrangement shall be as mutually agreed to between the user and the supplier.

Field assembly maintenance, cost of operation, and capitalized cost of maintenance during equipment life will be considered in bid evaluations. To elicit a complete and uniform response from each bidder, proposal data is provided in clause 7.

2. References

The following publications shall be used in conjunction with this guide:

ASTM D2472-1992, Specification for Sulfur Hexafluoride.¹

IEC 859:1986, Cable Connections for Gas-insulated Metal-Enclosed Switchgear for Rated Voltages of 72.5 kV and above.²

IEC 1129:1992, Alternating Current Earthing Switches—Induced Current Switching.

IEC 1639: 1996, Direct Connections Between Power Transformers and Gas-Insulated Metal-Enclosed Switchgear for Rated Voltages of 72.5 kV and Above.

IEEE Std 100-1996, The IEEE Standard Dictionary of Electrical and Electronic Terms.³

IEEE Std 1300-1996, Guide for Cable Connections for Gas-Insulated Substations.⁴

IEEE Std C37.09-1979 (Reaff 1988), IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (ANSI).

IEEE Std C37.122-1993, IEEE Standard for Gas-Insulated Substations (ANSI).

IEEE Std C57.13-1993, IEEE Standard Requirements for Instrument Transformers (ANSI).

IEEE Std C62.11-1993, IEEE Standard for Metal-Oxide Surge Arrestors for AC Power Circuits (ANSI).

NEMA CC 1-1993, Electric Power Connectors for Substations.⁵

NFPA 70-1996, National Electrical Code® (NEC®).⁶

In the event of conflict between the referenced standards, the drawings of the user, and specified requirements, or between standards issued by different authorities, the more stringent requirements are to apply.

3. Definitions

The following definitions are applicable only to the subjects treated in this guide.

3.1 catastrophic failure: A failure of any portion of the GIS due to internal or external faults that results in sufficient damage to that portion of the GIS that it cannot be returned to service without major repairs.

3.2 clearly discernable: Capable of being noticed easily without close inspection.

3.3 retransmit contacts: Auxiliary contacts on an annunciator that provide an output to a remote device to indicate that the annunciator has been actuated.

¹ASTM publications are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

²IEC publications are available from IEC Sales Department, Case Postale 131, 3, rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

³This standard will be available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA, in early Spring, 1997.

⁴IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁵NEMA publications are available from the National Electrical Manufacturers Association, 1300 N. 17th St., Ste. 1847, Rosslyn, VA 22209, USA.

⁶NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

4. Conditions

4.1 Environmental

All apparatus should be capable of satisfactory operation in the following environments:

Indoor or outdoor:

Elevation above sea level	_____	m
Maximum ambient temperature	_____	°C
Minimum ambient temperature	_____	°C
Humidity (average)	_____	%
Wind velocity	_____	km/h
Solar radiation	_____	W/m ²
Maximum ice loading	_____	mm
Maximum uplift	_____	N
Maximum impact	_____	N

Seismic:

Horizontal force	_____	g
Vertical force	_____	g

Air quality:

_____	_____	g
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Special environmental considerations:

_____	_____	g
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Values are to be in accordance with IEEE Std C37.122-1993.⁷

4.2 Equipment and services furnished by the user

Unless otherwise specified or agreed upon, the user should receive, install, and field test the apparatus specified herein. Installation and field testing of the GIS should be completed under the supervision of the supplier to ensure correct installation. Unless otherwise specified, the following equipment and services should also be furnished by the user:

- a) Concrete foundations
- b) Power transformers or reactors, including bushings
- c) Surge arresters outside the GIS
- d) The station ground grid, below ground, and vertical connection risers of adequate length

⁷Information on references can be found in clause 2.

- e) Ac and dc auxiliary power to furnished equipment
 - 1) Rated dc service voltage _____ V
 - 2) Minimum dc service voltage _____ V
 - 3) Maximum dc service voltage _____ V
 - 4) Rated ac service voltage (three-phase) _____ V
 - 5) Rated ac service voltage (one-phase) _____ V
- f) Hoist or crane
- g) Supervisory control and data acquisition (SCADA) equipment
- h) Conduit or troughs and wiring to supplier-furnished equipment
- i) Gas handling equipment
- j) Batteries and battery chargers
- k) Protective relaying systems
- l) Transmission-line dead-end terminations
- m) Control and power cable trenches
- n) Erection labor, with the supervision and assistance of the GIS supplier
- o) Control house and related equipment or building in case of indoor installation, including crane, if applicable
- p) Job-site unloading and storage
- q) Field welding, if required, with the supervision and assistance of the GIS supplier
- r) Test equipment, coordinated with the GIS supplier
- s) Specific tertiary bus and other related equipment
- t) High-voltage power cables and terminations
- u) Anchor bolts and/or embedded steel, if part of foundation pouring

4.3 Equipment and services furnished by the supplier

The supplier should design, manufacture, test, deliver, and guarantee the following services as recommended by this guide:

- a) The complete gas-insulated switchgear, including connections to power transformers and line exits with associated circuit breakers, disconnect and grounding switches, voltage transformers, and surge arresters.
- b) All metal-enclosed gas-insulated buses for interconnecting various switchgear assemblies, including flexible joints to ensure service continuity during thermal cycling and vibration.
- c) All cable connections, including SF₆ enclosures, terminator support structures, and mounting insulators should be as specified in IEC 859: 1986 and IEEE Std 1300-1996.
- d) All transformer and reactor bushing sulfur hexafluoride (SF₆) enclosures, complete with vibration dampers and/or alignment bellows, if required.
- e) All coordination with power transformer, reactor, cable, and cable termination suppliers to assure proper electrical and mechanical interface, in accordance with IEC 859: 1986 and IEC 1639: 1996.
- f) All necessary supports, platforms, stairways, and walkways, including fasteners to foundation. Final design of platforms and walkway systems is to be by mutual agreement between the user and the supplier.
- g) All auxiliary equipment, for emergency control and local supervision, including interlocks; operating mechanisms; and control, monitoring and protective devices, installed in suitable cabinets.