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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Nuclear facilities – Electrical power systems – Diesel generator units applied as standby power sources

Installations nucléaires – Systèmes d'alimentation électrique – Unités de générateur diesel utilisées comme sources d'alimentation de secours

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NUCLEAR FACILITIES – ELECTRICAL POWER SYSTEMS: DIESEL GENERATOR UNITS APPLIED AS STANDBY POWER SOURCES

FOREWORD

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IEC/IEEE 63332-387 was prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation, in cooperation with Nuclear Power Engineering Committee of the IEEE Power and Energy Society, under the IEC/IEEE Dual Logo Agreement between IEC and IEEE.

This document is published as an IEC/IEEE Dual Logo standard.

This new edition supersedes IEEE Std 387-2017 and therefore constitutes a first edition of the standard published under the IEC/IEEE Dual Logo agreement. This document contains the following technical changes with respect to IEEE Std 387-2017:

- This revision incorporates current practices and lessons learned from the implementation of previous versions of this document by the nuclear industry. Additionally, several issues are clarified or changed in this revision.
- This document defines the methods for design and testing of a diesel generator (DG) unit to provide reasonable assurance that in the event it is required to perform its safety functions during a plant emergency condition, it is readily available and capable given the environments to which it can be exposed. This dual logo standard applies to all electrical equipment important to safety in accordance with IAEA terminology including class 1E equipment in accordance with IEEE classification scheme and classes 1, 2 and 3 in accordance with IEC 61226 classification scheme. This document is generally intended for DGs to be utilised as equipment important to safety located in mild environments. The standard may be used in applications where a highly reliable onsite alternating current (AC) power source is required to maintain plant safety following an event with potential loss of offsite power for an extended duration. The documentation and qualification requirements, however, can be less rigorous or different.
- The definitions and terms used in IEC/IAEA standards and guides have been added to support the terminology used in IEEE standards.
- Incorporation of recent industrial experience in the area of DG unit best practices for maintenance and testing.

The text of this International Standard is based on the following IEC documents:

Draft	Report on voting
45A/1536/FDIS	45A/1553/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with the rules given in the ISO/IEC Directives, Part 2, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications/.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

a) Technical background, main issues and organization of the standard

This IEC/IEEE international standard defines the standard criteria for the application and testing of diesel generator (DG) units used as standby power supplies in nuclear facilities. This dual logo standard applies to DG units as relevant for electrical equipment important to safety in accordance with IAEA terminology including all equipment important to safety in accordance with the IEEE classification scheme.

The provisions of this document are divided into the following clauses:

Clause 5: Principal design criteria,

Clause 6: Factory production testing,

Clause 7: Qualification requirements,

Clause 8: Site testing.

This document harmonizes in a unique standard practice formerly given by IEEE Std 387-2017 on sizing, testing, qualification, and operational requirements of diesel engine-driven onsite power sources. This document also considers the general requirements on electrical power systems provided in IEC 63046 and assesses current practices and operating experience on the current fleet of nuclear facilities with a perspective on safety significance of the performance requirements of DG units during accident mitigation.

This document is applicable to the DG units of new nuclear facilities and upgrading or back-fitting of existing facilities. It is intended that the standard be used by operators of nuclear facilities, design engineers, systems evaluators and by licensors.

b) Situation of the current standard in the structure of the IEC/SC 45A standard series

The entry point for the IEC/SC 45A standard series is the two first-level standards providing general requirements on instrumentation and control (IEC 61513) and electrical power systems (IEC 63046) for nuclear facilities.

IEC/IEEE 63332-387 is a second level IEC/SC 45A document under IEC 63046 which focuses on criteria for the application and testing of DG units used for standby power supplies for electrical equipment important to safety in nuclear facilities.

For more details on the structure of the IEC/SC 45A standard series, see paragraph d) of this introduction.

c) Recommendations and limitations regarding the application of the standard

An important concept is that the current fleet of operating reactors with forced cooling and immediate need for alternating current (AC) powered equipment following an emergency or off-normal condition necessitates safety classified onsite power sources. Designs with passive cooling systems preclude the need for immediate AC driven pumps and motors. However, following the events at Fukushima Daiichi nuclear plant, and requirements for design extension conditions, onsite AC power system(s) are required to make up inventory and perform core cooling functions after the passive systems have performed the immediate safety functions at the onset of an event. Diesel engine driven AC power sources can be used to provide the power necessary to perform the functions important to safety in order to maintain safe state conditions in all types of plant designs.

It is important to note that this document establishes no additional functional requirements for safety systems.

To ensure that the standard will continue to be relevant in future years, the emphasis has been placed on issues of principle, rather than specific technologies.

d) Description of the structure of the IEC/SC 45A standard series and relationships with other IEC documents and other bodies' documents (IAEA, ISO)

The IEC/SC 45A standard series comprises a consistent set of documents organised in a hierarchy of four levels. The top-level documents of the IEC/SC 45A standard series are IEC 61513 and IEC 63046, covering respectively general requirements for instrumentation and control (I&C) systems and general requirements for electrical power systems of NPPs. IEC 61513 and IEC 63046 adopt an overall system life-cycle framework and constitute, along with the relevant second-level standards, the nuclear implementation of the basic safety series IEC 61508.

IEC 61513 and IEC 63046 refer directly to other IEC/SC 45A standards for general requirements for specific topics, such as categorization of functions and classification of systems, qualification, separation, defence against common cause failure, control room design, electromagnetic compatibility, human factors engineering, cybersecurity, software and hardware aspects for programmable digital systems, coordination of safety and security requirements and management of ageing.

At a third level, IEC/SC 45A standards not directly referenced by IEC 61513 or by IEC 63046 are standards related to specific requirements for specific equipment, technical methods, or activities. Usually, these documents refer to second-level documents for general requirements and can be used on their own.

A fourth level extending the IEC/SC 45A standard series corresponds to the Technical Reports which are not normative.

The IEC/SC 45A standards series consistently implements and details the safety and security principles and basic aspects provided in the relevant IAEA safety standards and in the relevant documents of the IAEA nuclear security series (NSS). In particular this includes the IAEA safety requirements SSR-2/1 (Rev 1), establishing safety requirements related to the design of nuclear power plants (NPPs), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPPs, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPPs, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPPs, the IAEA safety guide SSG-51 dealing with human factors engineering in the design of NPPs and the implementing guide NSS42-G for computer security at nuclear facilities. The safety and security terminology and definitions used by the SC 45A standards are consistent with those used by the IAEA.

IEC 61513 and IEC 63046 refer to ISO 9001 as well as to IAEA GSR part 2 and IAEA GS-G-3.1 and IAEA GS-G-3.5 for topics related to quality assurance (QA).

At level 2, regarding nuclear security, IEC 62645 is the entry document for the IEC/SC 45A security standards. It builds upon the valid high-level principles and main concepts of the generic security standards, in particular ISO/IEC 27001 and ISO/IEC 27002; it adapts them and completes them to fit the nuclear context and coordinates with the IEC 62443 series. At level 2, IEC 60964 is the entry document for the IEC/SC 45A control rooms standards, IEC 63351 is the entry document for the human factors engineering standards and IEC 62342 is the entry document for the ageing management standards.

NOTE 1 IEC TR 63400 provides a more comprehensive description of the overall structure of the IEC/SC 45A standards series and of its relationship with other standards bodies and standards.

NUCLEAR FACILITIES – ELECTRICAL POWER SYSTEMS: DIESEL GENERATOR UNITS APPLIED AS STANDBY POWER SOURCES

1 Scope

1.1 General

This document defines the criteria for the application and testing of diesel generator (DG) units used as safety class standby power supplies in nuclear facilities. In general, the standard applies to new nuclear facilities as well as for upgrading or back-fitting of existing facilities. Existing facilities can voluntarily adopt the requirements to enhance the performance capabilities and reliability of the installed DG units. The standard can be used in applications where highly reliable onsite alternating current (AC) power source is required to maintain plant safety following an event with potential loss of offsite power for an extended duration.

This document provides the principal design criteria, the design features, testing, and qualification requirements for the individual DG units that enable them to meet their functional requirements as a part of the standby power supply under the conditions produced by the design basis events cataloged in the plant safety analysis.

Figure 1 shows the boundaries of systems and equipment included in the scope of this document.

The following items are within the scope of this document:

a) The diesel engine, which includes the following:
   1) the flywheel and coupling (if applicable),
   2) the combustion air system and supply,
   3) the starting system including storage of energy,
   4) the starting energy system,
   5) the fuel oil supply system (e.g., including the day tank, filters, piping, pumps, valves and strainers between the day tank and the engine injection pumps),
   6) the lubricating oil system including keep-warm system,
   7) the cooling system (jacket water), starting at the point where the cooling medium is introduced to the DG unit. (For a closed loop water-cooling system (radiator) supplied as part of the DG unit, the starting point is water/air interface),
   8) the exhaust system,
   9) the governor system;
b) The generator, which includes the following:
   1) the excitation and voltage regulation system,
   2) the diesel generator output breaker at the switchgear,
   3) the diesel generator grounding (earthing) system;
c) The local control, protection, and surveillance systems associated with the diesel engine, the generator, and their auxiliary equipment and systems cited above. The design of control systems is not in the scope of this document. However, the functional criterion is provided;
d) The AC and direct current (DC) distribution systems associated with the diesel engine including the battery (if supplied with the generator) for starting, field flashing, the generator, and their auxiliary equipment and systems cited above, exclusive of the auxiliary power system beyond the generator output breaker;
e) Fuel oil storage system (e.g., storage tank, transfer pumps, filters, piping, valves, and strainers between the storage tank and the day tank);

f) Cooling air and ventilation system;

g) Those elements that are essential to the safety function of DG units within the scope of this document (see Figure 1);

h) Evaluation of the characteristics of the service environment relative to performance and qualification.

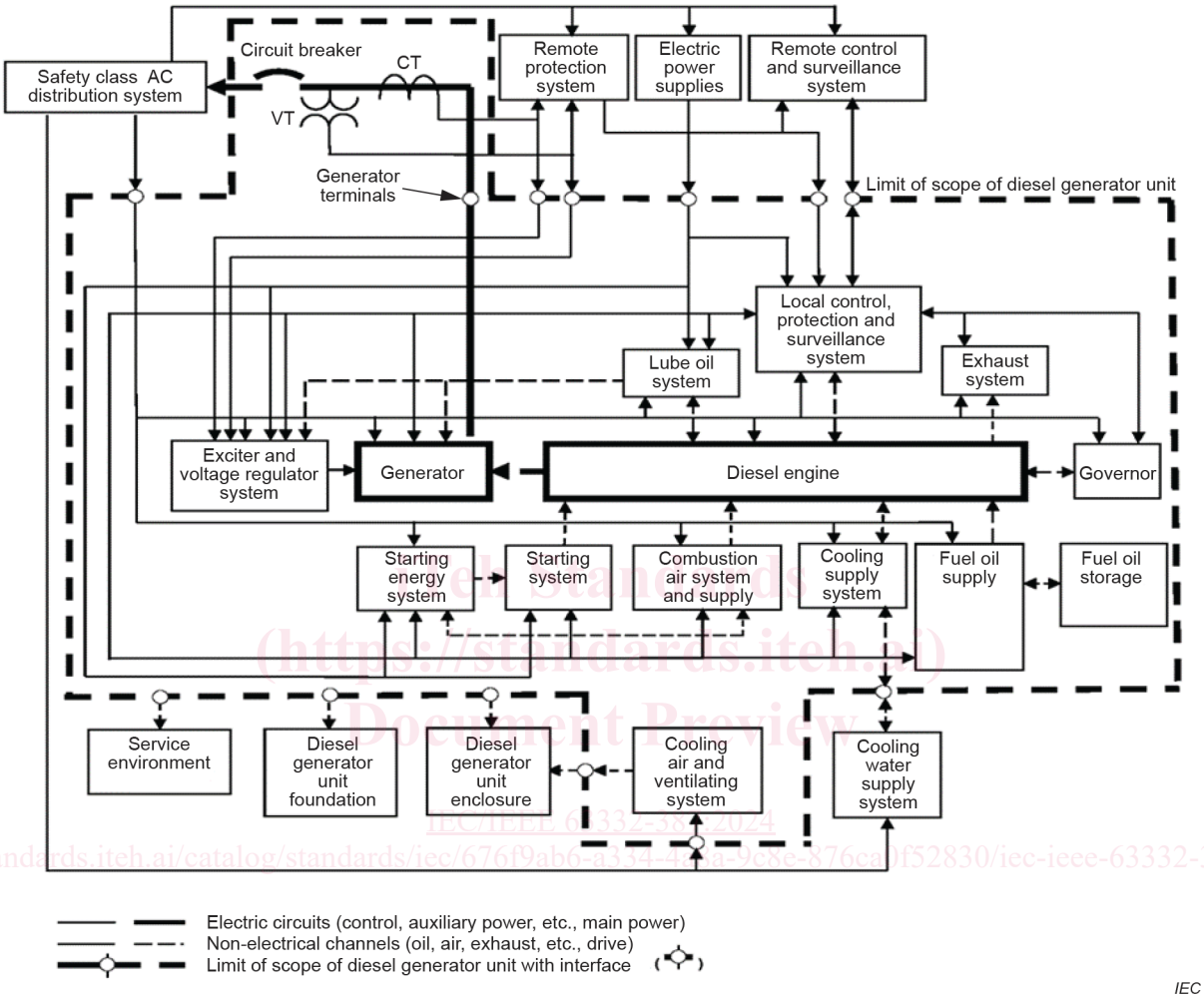

Figure 1 – Scope diagram

1.2 Inclusions for site testing

The following items are not in scope of the standard, and in general, the specific requirements might not be applicable. These items or systems are included as they are essential for the performance of the DG unit and also required for accomplishing site testing as described in Clause 8.

a) The AC and DC power distribution system, which includes the following:

   1) circuits for conveying AC power from the generator breaker up to and including the dedicated safety class bus,

   2) circuits for conveying AC or DC power to the DG units and associated controls,

   3) DC power supplies (batteries and chargers), if dedicated to the DG unit;

b) The remote and local control, protection (generator, engine, and auxiliaries), and surveillance systems, which include the following:
   1) devices for automatic and manual starting,
   2) devices for load shedding and sequencing,
   3) remote devices for the protection of the DG unit and its auxiliary equipment,
   4) synchronizing equipment.

1.3 Exclusions

The following items are not in the scope of this document:

a) DG unit enclosure and foundations;
b) External service equipment (e.g., Heating Ventilation and Air Conditioning (HVAC) system) and systems that are a part of, or that are housed in, the DG unit enclosure, other than those identified in 1.2;
c) The control, protection, and surveillance systems for the following:
   1) Protecting the loads energized by the DG unit,
   2) Prevention of common-cause failure between the preferred power supply and the standby power supply system;
d) Determination of the characteristics of the service environment;
e) Fire protection system.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60034 (all parts), *Rotating electrical machines*

IEC 61226, *Nuclear power plants – Instrumentation, control and electrical power systems important to safety – Categorization of functions and classification of systems*

IEC 62342, *Nuclear power plants – Instrumentation and control systems important to safety – Management of ageing*

IEC 63046, *Nuclear power plants – Electrical power system – General requirements*

IEC/IEEE 60780-323:2016, *Nuclear facilities – Electrical equipment important to safety – Qualification*

IEC/IEEE 60980-344, *Nuclear facilities – Equipment important to safety – Seismic qualification*

IEC/IEEE 62271-37-013:2021, *High-voltage switchgear and controlgear − Part 37-013: Alternating current generator circuit-breakers*

IEEE Std 308-2020, *IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations*

IEEE Std 450, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*

IEEE Std 485, *IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications*

IEEE Std 1106, *IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*

IEEE Std 1115, *IEEE Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications*

ASME OM, *Operation and Maintenance of Nuclear Power Plants (Division 2, Part 16, Performance Testing and Monitoring of Standby Diesel Generator Systems in Light-Water Reactor Power Plants)*

NEMA MG 1, *Motors and Generators*, available at http://www.nema.org/ [viewed 2024-03-11]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp
- IEEE Standards Dictionary Online: available at http://dictionary.ieee.org

3.1
acceptable
demonstrated to be adequate by the safety analysis of the plant

3.2
acceptance criteria
specified bounds on the value of a functional indicator or condition indicator used to assess the ability of a structure, system or component to perform its design function

[SOURCE: IAEA Nuclear Safety and Security Glossary, 2022]

3.3
accident
any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection and safety

[SOURCE: IAEA Nuclear Safety and Security Glossary, 2022]