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

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The UK participation in its preparation was entrusted to Technical Committee NCE/8, Instrumentation, Control & Electrical Systems of Nuclear Facilities.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2024

ISBN 978 0 539 14605 9

ICS 27.120.20

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2024.

Amendments/corrigenda issued since publication

Date	Text affected

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Full document details: BS IEC/IEEE 63332-387:2024

IEC/IEEE 63332-387

Edition 1.0 2024-09

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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ISBN 978-2-8322-0000-0

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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/.

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- withdrawn, or
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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.

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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.

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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);

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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.

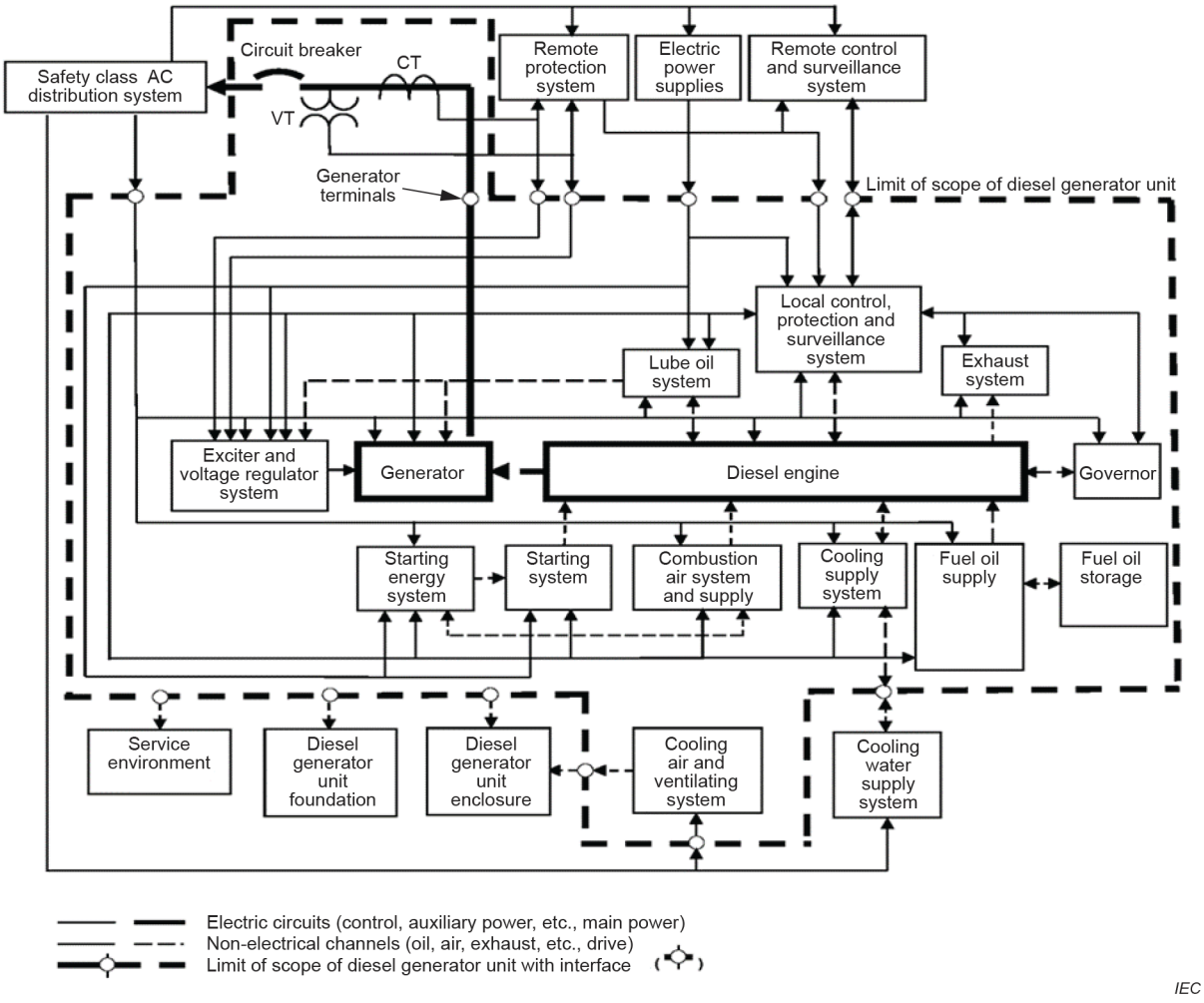


Figure 1 – Scope diagram

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;

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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*

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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]

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3.4
class 1E
safety classification of the electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or otherwise are essential in preventing significant release of radioactive material to the environment

Note 1 to entry: Users of this document are advised that “Class 1E” is a functional term. Equipment and systems are to be classified Class 1E only if they fulfil the functions listed in the definition. Identification of systems or equipment as Class 1E based on anything other than their function is an improper use of the term. The IAEA has corresponding classes into which *systems* and *components* and other items of equipment are assigned on the basis of their functions and their *safety* significance.

Note 2 to entry: Class 1E and Safety class are considered synonymous for electrical equipment and is a subset of equipment important to safety.

[SOURCE: IEC/IEEE 60780-323:2016, 3.3, modified – The notes to entry have been added.]

3.5
common cause failure
CCF
failures of two or more structures, systems or components due to a single specific event or cause

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

3.6
continuous rating
electric power output capability that the DG unit can maintain in the service environment for 8 760 hours (h) of operation per year with only scheduled outages for maintenance

3.7
design basis accident
postulated accident leading to accident conditions for which a facility is designed in accordance with established design criteria and conservative methodology, and for which releases of radioactive material are kept within acceptable limits

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

3.8
design basis events
postulated events used in the design to establish the acceptable performance requirements for the structures, systems, and components

[SOURCE: IEEE Standards Dictionary Online]

3.9
design load
combination of electric load (kilowatt (kW) and kilovolt-ampere reactive (kvar) having the most severe power demand characteristic, which is provided with electric energy from a DG unit for the operation of engineered safety features and other systems required during and following shutdown of the reactor

Note 1 to entry: Design load can include the term power factor.

3.10
diesel-generator unit
independent source of standby electrical power that consists of a diesel-fuelled internal combustion engine (or engines) coupled directly to an electrical generator (or generators), the associated mechanical and electrical auxiliary systems, and the control, protection, and surveillance systems

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3.11
design extension conditions
postulated accident conditions that are not considered for design basis accidents, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits

Note 1 to entry: For nuclear power plants and research reactors, design extension conditions comprise conditions in events without significant fuel degradation and conditions in events with melting of the reactor core

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

3.12
engine equilibrium temperature
condition at which the jacket water and lube oil temperatures are both within ± 5,5 °C (10 °F) of their normal operating temperatures established by the engine manufacturer

3.13
equipment important to safety
equipment that is part of a safety group and/or whose malfunction or failure could lead to undue radiation exposure of the site personnel or members of the public

Note 1 to entry: Equipment important to safety includes:

- those structures, systems and components that prevent anticipated operational occurrences from leading to accident conditions;
- those features that are provided to mitigate the consequences of malfunction or failure of structures, systems and components.

Note 2 to entry:

A) For usage consistent with IEC 61226, equipment important to safety are as follows:
   – all I&C equipment performing Category A to Category C functions (in accordance with the IEC 61226 categorisation scheme),
   – all electrical equipment needed to ensure emergency energy supply to this equipment in case of a loss of normal power supply,
   – all electrical equipment needed to ensure ultimate energy supply in case of total loss of on-site power (if selected as design extension condition to be mitigated).

B) For usage consistent with other IEEE documents and a Class 1E categorization; for equipment important to safety, qualification is essential to the following:
   – electric equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or
   – electric equipment that are otherwise essential in preventing significant release of radioactive material to the environment.

Note 3 to entry: Users of this document are advised that Class 1E is a functional term. Equipment and systems are classified Class 1E only if they fulfil the functions listed in the definition. Identification of systems or equipment as Class 1E based on anything other than their function is an improper use of the term.

[SOURCE: IEC/IEEE 60780-323:2016, 3.12, modified – examples of equipment important to safety have been changed to notes.]

3.14
equipment qualification
generation and maintenance of evidence to ensure that equipment will operate on demand, under specified service conditions, to meet system performance requirements

Note 1 to entry: Equipment is qualified for the duration of its operational performance requirement for each applicable DBE condition, including any required post-DBE operation period.

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

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3.15
equipment specification
document identifying all technical and quality assurance requirements for purchasing equipment, material, services and all requirements to meet the safety analysis of the plant

3.16
generator nameplate capacity
maximum amount of electric energy that a generator can produce within specified conditions (e.g., ambient temperature, elevation) as rated by the manufacturer

Note 1 to entry: Generator nameplate capacity is usually expressed in kilovolt-amperes (kVA) and kilowatts (kW), as indicated on a nameplate that is physically attached to the generator.

3.17
interfaces
shared boundary between structures, systems and components that includes physical attachments, mounting, auxiliary components, and connectors (electrical and mechanical) to the equipment

3.18
load-run demand
load-run following a successful start and involving defined acceptance criteria

Note 1 to entry: The applicable criterion may include:

- a load-run of any duration that results from a real (i.e., not a test) automatic or manual signal
- a load-run test to satisfy the plant's load and duration test specifications
- other operations (e.g., special tests) in which the DG unit is planned to run for at least 1 h with at least 50 % of design load

3.19
load-run demand failure
load-run when the DG unit starts but does not pick up the load and run successfully following a valid load-run demand with consideration to exceptions provided in the Note 2

Note 1 to entry: For monthly surveillance tests, the DG unit can be loaded at the rate recommended by the manufacturer or slow-started and reach rated speed on a prescribed schedule to reduce stress and wear on the diesel-generator unit. Any condition identified during maintenance inspections (with the DG unit in the standby mode) that definitely would have resulted in a load-run failure if a demand had occurred shall count as a valid load-run demand failure.

Note 2 to entry: Unsuccessful attempts to start or load-run shall not count as valid demands or failure when they can definitely be attributed to any of the following:

- any operation of a trip that would be bypassed in the emergency operating mode (e.g., high cooling-water temperature trip)
- malfunction of equipment that is not required to operate during the emergency operating mode (e.g., synchronizing circuitry)
- intentional termination of the test because of alarmed or observed abnormal conditions (e.g., small water or oil leaks) that would not have ultimately resulted in significant damage or failure of the DG unit
- component malfunctions or operating errors that did not prevent the DG unit from being restarted and brought to load within 5 min (i.e., without corrective maintenance or significant problem diagnosis)
- a failure to start because a portion of the starting system was disabled for test purposes, if followed by a successful start with the starting system in its normal alignment
- exploratory tests during corrective or preventive maintenance shall not count as demands or failures

3.20
load profile
magnitude and duration of loads (kW and kvar) applied in a prescribed time sequence, including the transient and steady-state characteristics of the individual loads

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3.21
loss of offsite power
simultaneous loss of electrical power to all unit safety buses, requiring the standby AC power sources to start and supply power to the safety buses

Note 1 to entry: DC systems and uninterruptible AC systems safety buses are not included

[SOURCE: IEC 63046:2020, 3.25]

3.22
margin
difference between service conditions and the conditions used for equipment qualification

[SOURCE: IEEE Standards Dictionary Online]

3.23
mild environment
environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences

[SOURCE: IEC/IEEE 60780-323:2016, 3.18]

3.24
preferred power supply
power supply from the transmission system to the Class 1E distribution system that is preferred to furnish electric power under accident and post-accident conditions

Note 1 to entry: Per IAEA SSG-34 Definitions: The preferred power supply is the power supply from the transmission system to the safety classified electrical power system.

[SOURCE: IEEE Standards Dictionary Online]

3.25
power factor
ratio of real (active) power (kW) to apparent power (kVA), expressed as $\cos \phi$ = kW/kVA = $kW/(kW^2 + kvar^2)^{1/2}$ where kvar is the reactive power

Note 1 to entry: The design-load power factor is determined by the plant-specific loading analysis and the rated power factor is defined by the OEM and is the capability of the DG unit.

3.26
qualified life
period for which a structure, system or component has been demonstrated, through testing, analysis or experience, to be capable of functioning within acceptance criteria during specific operating conditions while retaining the ability to perform its safety functions in accident conditions for a design basis accident or a design basis earthquake

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

3.27
safety class
for nuclear power plants, the classes into which systems and components and other items of equipment are assigned on the basis of their functions and their safety significance

Note 1 to entry: Class 1E and safety class are considered synonymous for electrical equipment and is a subset of equipment important to safety.

[SOURCE: IAEA Nuclear Safety and Security Glossary, 2022, modified – The note to entry has been added.]

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3.28
safety system
system important to safety, provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and design basis accidents

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

3.29
service environment
aggregate of conditions surrounding the DG unit in its enclosure, while serving the design load during normal, accident, and post-accident operation

3.30
service life
period from initial operation to final withdrawal from service of a structure, system or component

Note 1 to entry: The projected service life could be reduced by shelf life for age-sensitive components.

[SOURCE: IAEA Nuclear Safety and Security Glossary, 2022, modified – The note to entry has been added.]

3.31
severe accident
accident more severe than a design basis accident and involving significant core degradation

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

3.32
short-time rating
<diesel-generator unit> electric power output capability that the DG unit can maintain in the service environment for 2 h in any 24 h period, without exceeding the manufacturer's design limits and without reducing the maintenance interval established for the continuous rating

Note 1 to entry: Operation at this higher rating does not limit the use of the DG unit at its continuous rating.

3.33
single failure criterion
SFC
criterion (or requirement) applied to a system such that it must be capable of performing its task in the presence of any single failure

Note 1 to entry: To ensure that the single failure criterion is met, usually two or more independent (redundant) systems or trains are provided by design to achieve the same safety function

Note 2 to entry: The following exception applies to single failure criterion as used for DG units:

- Any single failure within the DG unit system that prevents the generator from performing the safety function is considered a single failure. Failure of one subsystem installed as part of redundant (or multiple) channels to improve the reliability of a DG unit is not considered a single failure unless the consequences of the failure prevent the DG unit from performing its safety function.

[SOURCE: IAEA Nuclear Safety and Security Glossary, 2022, modified – The note 2 to entry has been added].

3.34
standby power supply
power supply that is selected to furnish electric energy when the preferred power supply is not available

[SOURCE: IEEE Standards Dictionary Online]

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3.35
start demands
all valid and inadvertent starts, including all starts that are followed by load-runs, whether by automatic or manual initiation, and situations where the DG unit is started, but no attempt is made to load the DG unit

Note 1 to entry: The following conditions may apply to start demand failures:

- Any failure within the DG unit system that prevents the generator from achieving a specified frequency (or speed) and voltage within specified time allowance is classified as a valid start failure. For monthly surveillance tests, the DG unit can be brought to rated speed and voltage in the time recommended by the manufacturer to reduce stress and wear.
- Any condition identified during maintenance inspections (with the DG unit in the standby mode) that would definitely have resulted in a start failure if a demand had occurred shall count as a valid start demand and failure.

3.36
start signal
input signal to the DG unit start logic that initiates a DG unit start sequence

Note 1 to entry: The start signal can be the result of a planned (manual) demand or actual demand such as an automatic/emergency start signal

3.37
start time
elapsed time between receipt of an emergency start signal and achieving voltage and frequency for breaker closure to energize required loads

3.38
surveillance testing
periodic testing to verify that structures, systems and components continue to function or are capable of performing their functions when called upon to do so

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

3.39
total integrated dose
total cumulative dose
calculated dose the equipment would be subjected to in its service life (40 years or 60 years) and the bounding dose from the worst-case design basis event for the required period of operation

Note 1 to entry: If qualification in radiation environment is applicable, follow guidance in IEC/IEEE 60780-323.

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4 Abbreviated terms

AC	alternating current
DBE	design basis event
DC	direct current
DG	diesel generator
ECCS	emergency core cooling system
FAT	factory acceptance test
HVAC	heating ventilation and air conditioning
LOCA	loss of coolant accident
LOOP	loss of offsite power
MOV	motor-operated valve
NPP	nuclear power plant
OEM	original equipment manufacturer
OPC	open phase condition
RTD	resistance temperature detector
SBO	station blackout
var	volt-ampere reactive power

5 Principal design criteria

5.1 Capability

5.1.1 General

When in service, each DG unit shall have the capability of performing the safety functions of a standby power supply, in accordance with the requirements stated in IEEE Std 308 and IEC 63046.

5.1.2 Mechanical and electrical capabilities

5.1.2.1 General

The variations of voltage, frequency, and waveform (including the effects of harmonic distortion) of the DG unit shall not degrade the performance of any equipment important to safety below an acceptable level (see also Annex F). The DG unit shall also meet each of the following specific capabilities related to the design, application, and qualification requirements of this document.

5.1.2.2 Design conditions

The unit shall be capable of operating during and after any design basis event without support from the preferred power supply system. The following design conditions, including appropriate margins as required by IEC/IEEE 60780-323, shall be specified by those individuals responsible for the system application and, as a minimum, shall include the following:

a) operational cycles (e.g., 4 000 starts over a period of 40 years or 6 000 starts over a period of 60 years),

b) operating hours (e.g., 6 000 h over a period of 40 years or 9 000 h over 60 years),

c) operate continuously for an extended duration when external events impair offsite power sources,

d) temperature at equipment locations (minimum and maximum with durations and average annual ambient),

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