Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 3705 (11/2006)

Switchgear, Transformers and Distribution Networks for the Electrical Power Supply of the Safety System in Nuclear Power Plants

(Schaltanlagen, Transformatoren und Verteilungsnetze zur elektrischen Energieversorgung des Sicherheitssystems in Kernkraftwerken)

Previous versions of this safety standard
were issued in 09/1988 and 06/1999

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KTA SAFETY STANDARD

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Contents

PLEASE NOTE: Only the original German version of this safety standard represents the joint resolution of the 50-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger BAnz No. 245b of December 30, 2006. Copies may be ordered through the Carl Heymanns Verlag KG, Luxemburger Str. 449, 50939 Koeln, Germany (Telefax +49-221-94373603).

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Comments by the Editor:

Taking into account the meaning and usage of auxiliary verbs in the German language, in this translation the following agreements are effective:

shall	indicates a mandatory requirement,
shall basically	is used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. It is a requirement of the KTA that these exceptions - other than those in the case of **shall normally** - are specified in the text of the safety standard,
shall normally	indicates a requirement to which exceptions are allowed. However, exceptions used shall be substantiated during the licensing procedure,
should	indicates a recommendation or an example of good practice,
may	indicates an acceptable or permissible method within the scope of this safety standard.

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying those safety-related requirements which shall be met with regard to precautions to be taken in accordance with the state of science and technology against damage arising from the construction and operation of the plant (Sec. 7 para. 2 subpara. 3 Atomic Energy Act) in order to attain the protective goals specified in the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV) and further detailed in the "Safety Criteria for Nuclear Power Plants" and in the "Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactors Against Design Basis Accidents as Defined in Sec. 28 para. 3 StrlSchV – Design Basis Accident Guidelines" (the version released Oct. 18, 1983).

(2) Based on the Safety Criteria of the Federal Ministry of Interior, specifically, Criterion 7.1 “Emergency Power Supply”, the present safety standard specifies the requirements that apply to switchgear, transformers and distribution networks for the electrical power supply of the safety system in nuclear power plants.

(3) It is presumed that the conventional provisions and standards (e.g. legal accident prevention provisions, DIN standards, VDE regulations) are adhered to unless the specific conditions of nuclear power plants call for other requirements.

(4) The present safety standard specifies superordinate requirements for the design and analysis as well as for the design and testing of component-specific requirements for switchgear, transformers and distribution networks for the electrical power supply of the safety system in nuclear power plants.

(5) Superordinate requirements for the electrical power supply in nuclear power plants are specified in safety standard KTA 3701.

(6) The requirements for emergency power generating facilities with diesel generator units in nuclear power plants are specified in safety standard KTA 3702.

(7) The requirements for emergency power generating facilities with batteries and rectifier units in nuclear power plants are specified in safety standard KTA 3703.

(8) The requirements for emergency power facilities with rotary converters and static inverters in nuclear power plants are specified in safety standard KTA 3704.

(9) Within the framework of the KTA safety standards, the emergency power facilities are considered as ending at the connection terminals of the individual power loads. Requirements for the power loads are, therefore, specified in the component-specific safety standards

KTA 3501 Reactor Protection System and Monitoring Equipment of the Safety System

and

KTA 3504 Electrical Drives of the Safety System in Nuclear Power Plants.

(10) The requirements for fire protection of mechanical and electrical components in nuclear power plants are specified in safety standard KTA 2101.3.

(11) The requirements for the design of nuclear power plants against lightning are specified in safety standard KTA 2206.

(12) The requirements for the procedure for verifying the safety of mechanical and electrical plant components against earthquakes are specified in safety standard KTA 2201.4.

(13) General requirements regarding quality assurance are specified in safety standard KTA 1401.

1 Scope

This safety standard applies to the switchgear, transformers and distribution networks for the power supply of the safety system in nuclear power plants. The scope of the superordinate requirements specified in Section 3 ends with the circuit breakers of the offsite-power connections. The scope of the component-specific requirements for the design and testing of switchgear, transformers and distribution networks specified in Sections 4 and 5 ends at the high-voltage terminals of the offsite-power connection transformers.

Note:
Figure 1-1 *shows the boundary line of the scope of safety standard KTA 3705.*

2 Definitions

(1) Switchgear

A switchgear is an assembly of high-voltage or low-voltage components for switching, measuring, distributing and controlling as well as for the electrical protection within the framework of supplying power to power loads.

(2) Selectivity of electric protective features

Selectivity of electric protective features means the interaction of protective features such that, in the case of a short-circuit or an overcurrent, only that protective feature that is series-connected upstream and closest to the fault location will lead to an interruption of the fault current.

(3) Distribution network

A distribution network comprises the cables, lines, busbars as well as the terminal and connecting elements between the connecting terminals of the switchgear, the power generating facilities, the transformers and the power loads.

3 Superordinate Requirements for Design and Analysis

3.1 General Requirements

(1) The design of the switchgear, the distribution networks, the feeding generator units, the transformers and the power loads (e.g., motors for machines, actuators, solenoid valves, cabinets for control and instrumentation equipment) shall be coordinated such that the design loads which are presumed to act on the components will not be exceeded. In particular, the following requirements shall be met:

a) The static and dynamic limit values specified with respect to the permissible supply voltages and frequencies of the power loads shall not be exceeded.

b) The loads specified as permissible for the components shall not be exceeded in case of short-circuits currents and overcurrents.

c) Protective features shall not be triggered as a result of voltage, frequency and current transients that may occur during operating procedures. Furthermore, the operating procedures shall not trigger any automatic switchover nor the emergency power operation of diesel generator units.

Tables 3-1 through **3-4** show examples for coordinating the voltage design and the adjustments of corresponding limit values and time delays between the switchgear, transformers, distribution networks and power loads of the emergency power system.

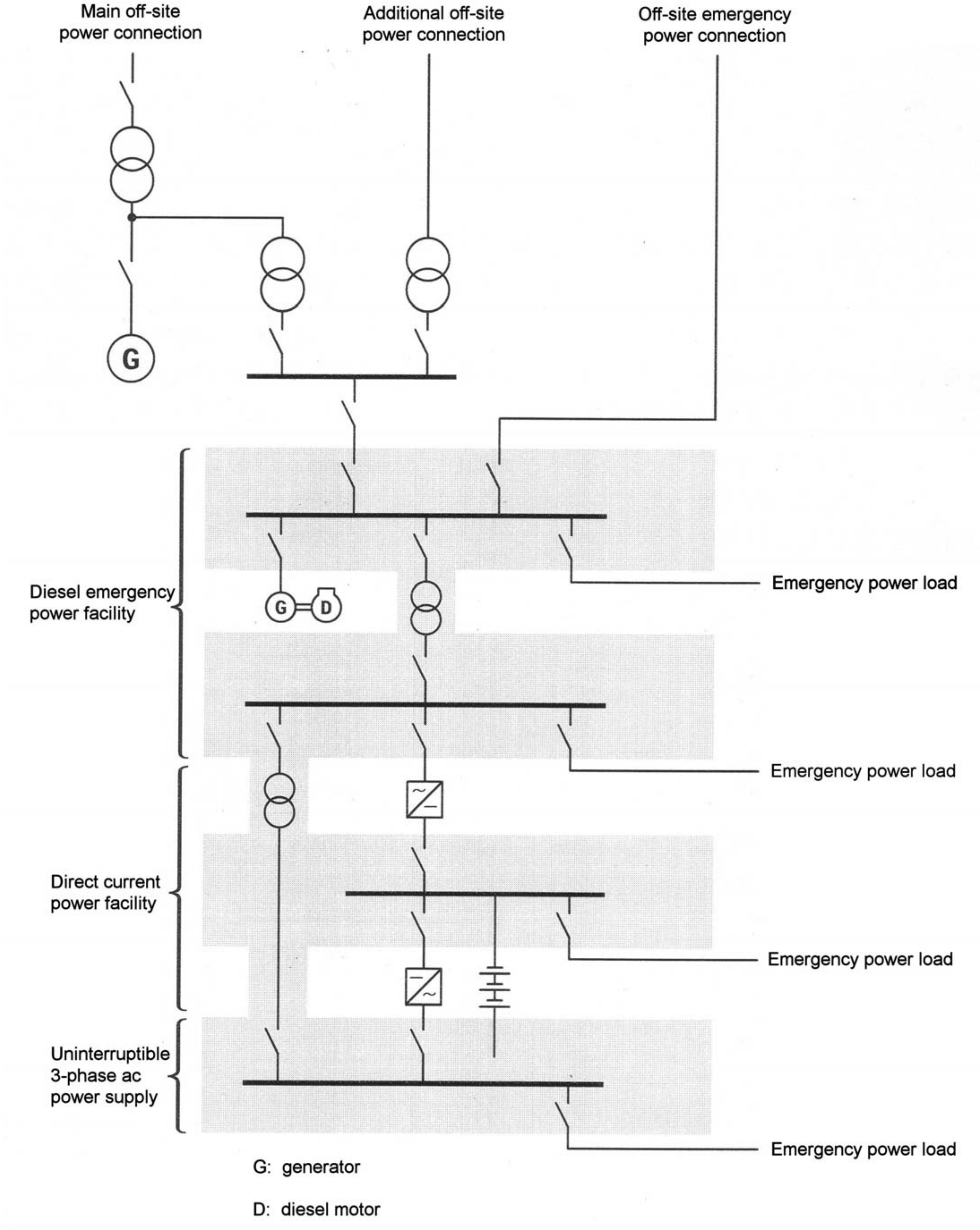

Figure 1-1: Boundary line of the scope of safety standard KTA 3705

Item No.	Characteristic Value / Measure	Design Values	Limit Values	Time Delay	Cf. Footnote
1	Mean static voltage during operation of isolated plant unit	1.05 U_N	–	–	–
2	Annunciation (alarm or display)	–	0.95 U_N	approx. 30 s	a
			1.10 U_N		
3	Switchover to additional offsite power connection	–	0.83 U_N	approx. 0.5 s	–
4	Startup of diesel generator units	–	0.80 U_N	approx. 2.0 s	a
5	Startup voltage of the high-voltage motors of the safety system	0.75 U_N	–	–	b
6	Startup voltage of low-voltage motors actuating the machines of the safety system for a voltage drop between the diesel generator busbar and the motor connection terminals that is smaller than or equal to 0.10 U_N	0.70 U_N	–	–	b
7	Protective disconnection or shutdown of the low-voltage power loads	–	0.70 U_N	–	c
8	Reconnection of the low-voltage power loads	–	0.80 U_N	–	c

U_N nominal voltage of the motors at the individual voltage level

a voltage measurement at the diesel generator busbar

b voltage at the motor terminals during startup following decay of the transient startup current peak

c time delay is dependent on the kind of switching device (contactors, latched switching devices) and on the requirements in terms of operating procedure

Tables 3-1: Diesel emergency power supply

Example for coordinating the voltage design between the switchgear, transformers, distribution networks and the machine-actuating motors connected to the diesel emergency power supply

Item No.	Characteristic Value / Measure	Design Values	Limit Values	Time Delay	Cf. Footnote
1	Static voltage range of the collective busbar	1.03 to 1.07 U_N	–	–	a
2	Annunciation (alarm or display)	–	0.95 U_N	approx. 30 s	b
			1.10 U_N		
3	Startup voltage of low-voltage motors actuating, e.g., the control drives of the safety system, for a voltage drop between the converter busbar and the motor terminals is smaller than or equal to 0.2 U_N	0.80 U_N	–	–	c
4	Startup voltage of low-voltage motors actuating, e.g., the control drives of the safety system, for a voltage drop between the converter busbar and the motor terminals is smaller than or equal to 0.1 U_N	0.90 U_N	–	–	c

U_N nominal voltage of the motors at the individual voltage level

a if the required voltage level is adjusted to 1.05 U_N

b voltage measurement at the converter busbars

c voltage at the motor terminals during startup following decay of the transient startup current peak

Table 3-2: Converting or inverting emergency power supply

Example for coordinating the voltage design between the switchgear, transformers, distribution networks and the control-drive-actuating motors connected to the converting or inverting emergency power supply

Item No.	Characteristic Value / Measure	Design Values	Limit Values	Time Delay	Cf. Footnote
1	Static range of the busbar voltage during trickle charge operation (13-cell lead battery; 2.23 V per cell)	28.7 to 29.3 V	–	–	–
2	Protective disconnections of the rectifiers	–	33.0 V	non–delayed	–
			30.5 V	approx. 1.0 s	–
			25.0 V	delayed	a
3	Annunciation (alarm or display)	–	27.0 V	approx. 25 s	b
4	Minimum specified battery voltage (1.85 V per cell)	24 V	–	–	–
5	Minimum permissible voltage at the connection terminals of an instrumentation and control cabinet for a voltage drop between the battery terminals and the input terminals of the instrumentation and control cabinet of less than or equal to 3 V and the battery voltage as specified under Item No. 4	21.0 V	–	–	c
6	Minimum permissible voltage at the connection terminals of a measurement transducer cabinet for a voltage drop between the battery terminals and the input terminals of the measurement transducer cabinet of less than or equal to 2 V and the battery voltage as specified under Item No. 4	22.0 V	–	–	c

a the direct-current under-voltage is monitored as short-circuit protection; time delay results from the energizing of the rectifier

b time delay results from diesel startup pause

c specified voltage, measured behind the decoupling diode of the cabinet feeder branch, e.g., for a voltage equal to 20 V at the terminals of the control subunit, or equal to 18 V at the terminals of a measurement transducer

Table 3-3: 24 V direct-current supply

Example for coordinating the voltage design between battery facilities, switchgear, distribution network and the power loads connected to the 24 V direct-current switchgear (e.g., instrumentation and control cabinets)

Item No.	Characteristic Value / Measure	Design Values	Limit Values	Time Delay	Cf. Footnote
1	Static range of the busbar voltage during trickle charge operation (108-cell lead battery; 2.23 V per cell)	239 to 243 V	–	–	–
2	Protective disconnection of the rectifiers	–	260 V	non–delayed	–
			250 V	approx. 5.0 s	–
			190 V	delayed	a
3	Minimum specified battery voltage (1.8 V per cell)	194 V	–	–	–
4	Annunciation (alarm or display)	–	227 V	approx. 25 s	b
5	Minimum permissible voltage at the connection terminals of a power load for a voltage drop between the battery terminals and the input terminals of the power load of less than or equal to 7 V and at a battery voltage as specified under Item No. 3	–	187 V	–	c

a the direct-current under-voltage is monitored as short-circuit protection; time delay results from energizing of the rectifier

b e.g., by means of current dependent direct-current under-voltage monitoring

c e.g., for a converter unit

Table 3-4: 220 V direct-current supply

Example for coordinating the voltage design between battery facilities, switchgear, distribution network and the power loads connected to the 220 V direct-current switchgear

(2) The effects which failure-initiating events within switchgear, transformers and distribution networks for the power supply of the safety system may have on the nuclear power plant shall be investigated with regard to their permissibility.

(3) The selectivity in the auxiliary power system and the emergency power system shall normally be maintained. In the case of a diode-decoupled dual power supply of a direct-current power load from different trains, the selectivity within each of the supplying trains shall be maintained for any faults occurring within these power loads.

(4) The control and instrumentation features for the operation, monitoring and protection of switchgear, transformers and distribution networks of the emergency power system shall correspond to the train layout and the train allocation.

(5) Monitoring equipment shall be provided which, by means of displays and alarms, will enable identifying both the operating state and any exceeding of limit values. The monitoring equipment and their arrangement shall be such that the required tasks regarding operation, inspection, maintenance and repair during specified normal operation and during the design-basis accidents to be presumed can be performed to the extent required in each individual case.

3.2 Protection and Selectivity

(1) The layout of the circuits, the design of the electric components and the selection and adjustment of the protective features shall assure that any faults within the switchgear, transformers, distribution networks and power loads are detected and that any necessary protective disconnection or shutdown is performed. Any actuation of a protective feature shall trigger an annunciation that shall make it possible to recognize this fact.

(2) The protective features shall be designed such that faults are reliably registered, that any required protective disconnection or shutdown is performed and that spurious actuations due to operational transients are prevented. The actuation of a protective feature shall trigger an annunciation.

(3) The selectivity of protective features with respect to the minimum short-circuit current specified in Section 3.3 para. 3 shall be demonstrated on the basis of technical documents. In this context, operating currents, adjustments of time delays, tripping times, effects of corrective variables (e.g., temperature) on the individual tripping characteristic shall be taken into consideration together with their respective tolerances.

(4) In the case of failure of a short-circuit protective feature, the plant component affected by this failure shall normally be disconnected or shutdown by the nearest protective feature series-connected upstream of this plant component (standby protection). No standby protection is required for the protective disconnection or shutdown of short-circuits on the low-voltage end of transformers between transformer and circuit breaker. It is not required to assume that safety fuses will fail to trip.

(5) With regard to a more immediate protective disconnection of accidental arcs in a switchgear, protective features for the immediate protective disconnection or shutdown of the feeder branch may be provided in addition to the selective protective features.

(6) Overcurrent protective features shall be selected and adjusted such that, on the one hand, the minimum short-circuit currents are detected and, on the other hand, the current transients caused by operating procedures will not lead to a protective disconnection or shutdown. In this context, the startup currents of the largest single power load and that of the largest power load group shall be taken into consideration with special regard to the individual basic power loads and, furthermore, the re-acceleration currents (e.g. after brief voltage dips) of all connected power loads. The prevention of a protective disconnection or shutdown on account of operational current transients shall have priority over other requirements (e.g., standby protection, detection of minimum short-circuit currents).

Note:
This requirement of preventing a protective disconnection or shutdown of the feeder branch due to operational current transients can be fulfilled, e.g., by adjusting the short-circuit trigger to a value larger than or equal to 1.2 times the maximum sum of the startup currents of the power loads. In the case of electro-mechanical short-circuit triggers (primary triggers), the influence of the current transient (dc-component) shall be taken into consideration when switching on power loads or feeder branches. This requires that a safety margin dependent on the minimum short-circuit current is added on top of the symmetric startup current.

(7) The following conditions shall apply to the short-circuit protection on the high-voltage end of a transformer – in addition to the superordinate requirements for protective features specified in para. 6:

a) The instantaneous short-circuit trigger on the high-voltage end of the transformer shall normally be adjusted such that it will not cause any protective disconnection or shutdown of the transformer as a result of the sudden startup current of the transformer or, at the low-voltage end, in case of a short-circuit in power load branches.

   Note:
   This requirement can be met if, e.g., the immediate short-circuit trigger is adjusted to a value larger than or equal to 1.2 times the maximum short-circuit current of the low-voltage end as seen from the high-voltage end, and greater than or equal to 1.2 times the sudden startup current of the transformer.

b) The overcurrent trigger on the high-voltage end of the transformer shall be adjusted such that a minimum short-circuit current on the low-voltage end busbar will cause a protective disconnection or shutdown of the transformer.

   Note:
   This requirement can be met if, e.g., the overcurrent trigger is adjusted to a value smaller than or equal to 0.8 times the minimum short-circuit current of the low-voltage end as seen from the high-voltage end.

(8) In addition to the superordinate requirements for protective features as specified in para. 6, the following conditions shall be met by the short-circuit and overload protection of motors:

a) The immediate short-circuit trigger shall be adjusted such that the startup current peaks will not cause a protective disconnection or shutdown of the motor.

b) Overload protections for motors of machines shall be adjusted such that the procedurally required number of successive startup procedures will not cause a protective disconnection or shutdown of the motor. At the specified minimum startup voltage at the connection terminals, the design and adjustment of the protective features of continuously operating motors shall presume at least two successive startup procedures from cold state, or one startup procedure with the motor at operating temperature. Overload protections may not cause any protective disconnection or shutdown of the motor when the motor is operated at the specified minimum static terminal voltage for the specified period of time.

   Note:
   The startup procedures permissible for the thermal design of motors are specified in Sec. 7.2 para. 3 of safety standard KTA 3504.

c) Protective features with regard to the winding temperature shall normally be provided as overload protection for the control drives. If a current-dependent overload protection is used, it shall be adjusted such that it will not cause any protective disconnection or shutdown of the motor in the specified mode of operation (at least one operating sequence, CLOSED – OPEN – CLOSED, in the case of control drives).

3.3 Short-Circuit Current Calculation

(1) The maximum and minimum short-circuit currents shall be calculated for all voltage levels. The analytical procedure and the input data used shall be specified.

(2) When calculating the maximum short-circuit current, all partial short-circuit currents which may feed into the fault location shall be taken into consideration.

(3) When calculating the minimum short-circuit current, the smallest possible partial short-circuit current resulting from the following operating conditions shall be taken into consideration:

a) station service power supplied alone from the main generator of the plant-unit (island operation),

b) station service power supplied from the main offsite power connection at a minimum short-circuit power from the offsite power connection or, if applicable, only from one of the generator transformers connected in parallel,

c) station service power supplied from the additional offsite power connection with minimum line short-circuit power,

d) emergency power supplied from the diesel generator units,

e) emergency power supplied from an offsite power connection.

Note:
Depending on the circuit design and on the design of the component, the minimum short-circuit currents may be a result of triple-, double- or single-pole short-circuits.

(4) The short-circuit currents in three-phase current facilities shall be determined either with the analytical methods in accordance with DIN EN 60909-0 or with more precise analytical methods which are better adapted to the operating conditions. For calculating the minimum short-circuit current in the case of facilities with a nominal voltage above 1 kV, the factor required to determine the substitute voltage that feeds the short-circuit shall be assumed to be 0.95. In the case of components with a reduced tolerance with respect to those in accordance with VDE regulations, the calculation may be based on these reduced tolerances. If measurement values are available, e.g., for transformers, the calculation may be based on these values.

Note:
The analytical methods in accordance with DIN EN 60909-0 neglect, among others, electrical arc resistances. Therefore, in the case of low-voltage switchgear, the actually occurring short-circuit currents may be smaller than the minimum short-circuit currents calculated in accordance with DIN EN 60909-0.

(5) The determination of the maximum possible short-circuit currents in direct-current facilities shall be based on the following assumptions:

a) Those resistances to be taken into consideration shall be assumed to have a conductor temperature of 20 °C and to be at the lower limit value of the permissible deviation.

b) The assumed internal resistance of the battery shall be the resistance of the fully charged battery at the open-circuit voltage.

c) The short-circuit current characteristic of rectifier units including the startup pulse portion of the short-circuit current shall be taken into consideration.

d) The resistances of cables, busbars, fuses, diodes and shunt resistors may be taken into consideration.

e) The transfer resistances of connections, e.g., bolted joints, may be neglected.

f) The fractional contribution from the initial short-circuit current of motors shall be taken into consideration.

(6) The determination of the minimum possible short-circuit currents in direct-current facilities shall be based on the following assumptions:

a) All resistances along the short-circuit path shall be taken into consideration. They shall be related to the operating temperature and to the upper limit value of permissible deviations.

b) The assumed internal resistance of the battery shall be the resistance at the lowest specified battery voltage.

c) The short-circuit current portion of rectifier units may be neglected, provided, they are operated in parallel with the battery.

d) Insofar as the rectifier is not operated in parallel with a battery, the sustained short-circuit current to be assumed shall be that of the value of the current limiter of the rectifier unit. In this context, it is permissible to consider the development of the short-circuit current prior to the current limiter becoming effective.

3.4 Voltage Drop, Voltage Dip and Voltage Increase

(1) The permissible static and dynamic voltage limit values shall be specified for the electric power load, for the switchgear busbars and for the switchgear auxiliary circuits.

(2) In the operating modes to be assumed as specified in para. 6, the startup of motors or groups of motors shall not cause any voltage dips which would lead to an automatic switchover or to a diesel startup.

(3) Dynamic voltage dips resulting from short-circuits in power-load feeder branches or from the startup of motors shall not cause any permanent shutdown or impermissible interruption of other motors in operation.

(4) Both the maximum and minimum voltages occurring in the static and dynamic operating modes shall be determined for all voltage levels of the auxiliary power system supplying power to the safety system as well as of the emergency power system.

(5) Taking the voltage drops at the components into account, the minimum and maximum voltages as well as the static and dynamic voltages shall be determined at the power load connection terminals. The permissible limit values of the specified power load voltages shall not be exceeded in the operating modes to be assumed. The startup of motors (groups of motors) and the pre-loading of plant components as a result of power loads already connected shall be taken into consideration.

(6) The following operating modes shall be assumed:

a) stationary operation at the nominal power of the plant unit,

b) station service power supplied alone from the main generator of the plant-unit (island operation),

c) station service power supplied from the main offsite power connection at a minimum short-circuit power from the offsite power connection or, if applicable, only from one of the generator transformers connected in parallel,

d) station service power supplied from the additional offsite power connection with minimum line short-circuit power,

e) emergency power supplied from the diesel generator units,

f) emergency power supplied from an offsite power connection,

g) switchover to station service power,

h) load shedding to station service power, and

i) turbine trip starting from the permissible limit values of an overexcited and an underexcited generator operation, in particular, as a result of a reactor scram.

Note:
With regard to limiting voltage deviations in the case of a turbine trip, measures are provided which, e.g., on account of the turbine trip signal will immediately reset the step switches of the generator transformers or of the auxiliary power transformers such that the station service power supply will be restored to its nominal voltage as quickly as possible. In this context, the protective disconnection or shutdown of the generator will be delayed, provided, the cause of a turbine trip is not a fault in the generator.

(7) The analytical procedure and the input data used in determining the voltage drop and voltage dip shall be specified.

(8) If the overvoltages from lightning strikes, from insulation faults, or the switching overvoltages due to, e.g., grounding facilities, lightning protection facilities, voltage equalizers or shields, are not limited to voltage values below the dielectric strength of the connected power loads, then these overvoltages shall be limited by means of overvoltage protection facilities.

Note:
In direct current circuits, the switching overvoltages occurring when fuses trip shall be taken into consideration and shall, if necessary, be reduced by connecting available inductive loads (solenoids).

4 Component-Specific Design Requirements

4.1 Switchgear

4.1.2 Switchgear design

(1) Switchgear shall be designed to meet the most unfavorable ambient conditions to be specified at the individual location taking the required functions into account, and they shall meet the superordinate requirements contained in Section 3.

(2) Switchgear used for voltages above 1 kV shall normally be metal-clad, factory-built, type-tested high-voltage switchgear.

(3) Switchgear used for voltages up to and including 1000 V shall normally be type-tested low-voltage switchgear device combinations with plug-in- and slide-in-type components.

(4) Impermissible switching operations shall normally be prevented by interlocks. In the case of switchgear with nominal voltages above 1 kV, the following interlocks shall be provided in addition to the interlocks in accordance with DIN EN 62271-200 (VDE 0671-200):

a) The switchgear cart or the drawer shall not be capable of being moved into the operating position before all auxiliary circuits are connected.

b) When retracting the switchgear cart or the drawer, the auxiliary circuits shall not be capable of being disconnected before the proper disconnect position is reached.

c) The grounding switch shall not be capable of being switched on or off if the switchgear cart or drawer is not in a position at least as far out as the disconnected position.

d) The switchgear cart or drawer shall only be moveable from the disconnected position in direction of the operating position if the grounding switch is switched off.

e) Interlocks spanning beyond an individual switchgear bay, e.g., with respect to busbar grounding devices or other bus bars, shall be specified depending on the specifics of the plant.

(5) The design of switchgear for nominal voltages above 1 kV shall fulfill the following additional conditions:

a) Equipment which must be subjected to re-adjustments or inservice inspections shall normally not be located in the cable terminal compartment of feeder panels or in busbar compartments.

b) All circuit breakers shall be actuated with stored-energy methods. In this context, if the breaker is in the operational ON-position, enough energy for one OFF–ON–OFF cycle shall be stored, and, if the breaker is in the operational OFF-position, enough energy for one ON–OFF cycle. After a short-circuit protective disconnection or shutdown, a switching back to the ON-position shall normally be possible only after the alarm at the switchgear was properly acknowledged.

c) Branches in which a reverse voltage may occur shall be provided with grounding switches that are secured against inadvertent switching.

d) The different circuits shall be arranged and insulated such that the occurrence of any voltage breakdown between main circuits and auxiliary circuits can be considered as impossible.

(6) The circuits with voltages above 60 V and up to 1000 V shall be arranged and insulated such that any voltage breakdown to circuits with voltages of less than 60 V does not have to be assumed.

4.1.2 Monitoring and protection of switchgear

(1) The switch gear shall be provided with monitoring devices whose displays and alarms will make it possible to determine the functional operability, the operating state and any exceeding of limit values.

(2) In the case of slide-in type of devices, the unplugging of plug-in connections of the main and auxiliary circuits shall be monitored.

(3) The location of the monitoring devices shall meet the requirements of operation, maintenance and repair, and the monitoring devices shall normally be considered separately as follows:

a) displays and individual alarms at the switchgear,

and

b) displays, individual and group alarms in the main control room and, if necessary, in local control stations.

(4) The group alarms in the main control room shall be allocated to the Class I alarm signals; individual alarms may be allocated to Class II, provided, their origin can be localized.

Note:
Requirements regarding the design of the alarms are specified in Sec. 10 of safety standard KTA 3501.

(5) Protective features shall be provided which register faults within the switchgear, the distribution network and the power loads, and which initiate any necessary protective disconnection or shutdown. Protective features against overloads and short-circuits shall be adjusted with respect to the conductor cross sections required as specified in Sec-

tion 4.3.1 para. 5 and shall meet the requirements regarding protection and selectivity as specified in Section 3.2.

(6) **Table 4-1** and **Table 4-2** illustrate typical monitoring equipment and the protective disconnection or shutdown for a diesel emergency-power switchgear with a nominal voltage above 1 kV and for a diesel-emergency-power switchgear with a nominal voltage up to and including 1000 V.

4.1.3 Suitability of the emergency-power switchgear

(1) The suitability of the emergency-power switchgear for use in nuclear power plants shall be demonstrated by type approval tests and by a proof of successful operating experience.

(2) A switchgear may be assumed to be suitable if

a) a type approval test of the switchgear of this type has been performed successfully as specified in Section 5.2.1,

and

b) the successful operating experience of 50 panels of this type of switchgear with a comparable design of the feeder branches can be proven over a period of at least three years of operation under comparable operating conditions.

(3) In the case of indications of overloaded components, of wrongly selected materials or of other common-mode failures, a proof that the cause of failure has been removed shall be presented.

(4) If the switchgear to be used in the nuclear power plant has individual components which differ from those of the switchgear type used in the proof of successful operating experience, a separate suitability test on those components is permissible, however, only in substantiated cases.

(5) If the deployment in nuclear power plants requires additional safety-related properties, e.g., a design against loads from external events, and if these properties are not covered by the proof of successful operating experience and by the type approval tests as specified under Section 5.2.1, additional suitability tests shall be performed.

(6) Kind and scope of the suitability tests indicated in paras. 4 and 5 shall be specified in agreement with the authorized expert (under Sec. 20 Atomic Energy Act).

Item No.	Measured Variable / Criterion	Monitoring in		Protective Disconnection or Shutdown
		Switchgear Unit	Main Control Room	
1	**Switchgear cubicle**			
1.1	Switchgear cart or drawer not in operating position	M	M1	–
1.2	Control plug disconnected	M	M1, SM1	–
1.3	Control voltage, protective breaker released	M	M1, SM1, SM2	–
1.4	Stored-energy operation faulted	M	M1, SM1, SM2	–
1.5	Overload protection triggered	M	M1, SM1, SM3	S
1.6	Short-circuit protection triggered	M	M1, SM1, SM3	S
2	**Switchgear**			
2.1	Loss of auxiliary voltages for control and protection	M	SM2	–
2.2	Busbar, short to ground	M	SM2	–
2.3	Busbar, loss of measuring voltage	M	SM2	–
2.4	Busbar voltage faulted	A	A, $\underline{M}$, $\underline{\underline{M}}$, $\overline{M}$	–
2.5	Interfering electrical detected	M	SM2	S [1)]

A display

M annunciation

M1 annunciation by table panel light: feeder branch not in operating condition

SM1 group annunciation in each control room annunciation area: feeder branch faulted

SM2 group annunciation in each switchgear unit: switchgear unit faulted

SM3 group annunciation in each switchgear unit: overload or short-circuit protector released

$\overline{M}$ upper limit value annunciation

$\underline{M}$ first lower limit value annunciation: voltage, U, smaller than normal operating value, e.g., U less than 0.95 U_N, time delayed

$\underline{\underline{M}}$ second lower limit value annunciation: voltage, U, smaller than diesel start-up criterion, e.g., U less than 0,8 U_N, time delayed

S protective disconnection

1) see Section 3.2 para. 5

Table 4-1: Example of displays, annunciations and the protective disconnection or shutdown for diesel emergency-power switchgear with a nominal voltage above 1 kV

Item No.	Measured Variable / Criterion	Monitoring in Switchgear Unit	Monitoring in Main Control Room	Protective Disconnection
1	**Feeder branch**			
1.1	Drawer of remotely operated feeder branches not in operating position	M	M1	–
1.2	Control plug disconnected	M [1)]	M1, SM1	–
1.3	Control voltage, protective circuit breaker released	M	M1, SM1, SM2	–
1.4	Overload protection triggered	M	M1, SM1	S
1.5	Short-circuit protection triggered	M	M1, SM1 [2)]	S
2	**Group fusing**			
2.1	Fuses of overload and short-circuit protection triggered	M	SM2	S
3	**Switchgear**			
3.1	Loss of auxiliary voltages for control and protection	M	SM2	–
3.2	Loss of measuring voltage	M	SM2	–
3.3	Busbar voltage faulted	A	A, <u>M</u>	–
3.4	Short to ground (applies only to island-operated net-works)	M	SM2	–

A display

M annunciation

<u>M</u> lower limit annunciation

S protective disconnection

M1 annunciation by table panel light: feeder branch not in operating condition

SM1 group annunciation in each control room annunciation area: feeder branch faulted

SM2 group annunciation in each switchgear unit: switchgear unit faulted

1) In the case of feeder branches with power breakers, display via switchgear disturbance light; in the case of contactor feeder branches, disturbance can be identified from the drawer position.

2) In the case fuses are used as short-circuit protectors: annunciation SM1 is caused by tripping the fuse in the control voltage phase.

Table 4-2: Example of displays, annunciations and the protective disconnection or shutdown for diesel emergency-power switchgear with a nominal voltage up to and including 1000 V

4.2 Transformers

4.2.1 Design of the main transformer, the additional offsite power transformers and unit auxiliary transformers and the emergency-power distribution transformers

(1) The transformers shall be designed to be able to withstand the most unfavorable ambient conditions at their individual locations and they shall meet the superordinate requirements specified under Section 3 taking the required functions into consideration.

(2) The transformers shall be designed to be short-circuit-proof. In this context, the following conditions shall apply, in addition to DIN EN 60076-5 (VDE 0532-5):

a) The short-circuit shall be assumed to occur at the transformer terminals.

b) The following short-circuit durations shall normally be assumed:

ba) for the main transformer, the additional offsite power transformers and the plant unit auxiliary transformers: 6 seconds,

and

bb) for the emergency-power distribution transformers: 4 seconds.

c) The short-circuit current shall be calculated based on a current tapping that leads to the lowest percentage value of the short-circuit voltage.

d) The following values shall be assumed as source voltage for the short-circuit currents:

da) for the main transformer: $1.05 \times U_N$,

db) for the additional offsite power transformer: $1.1 \times U_N$,

dc) for the unit auxiliary power transformer, depending on the control range of the generator, e.g.: $1.05 \times U_N$,

and

dd) for the emergency-power distribution transformers: the upper static limit value of the feeding voltage.

(3) In the case of components with reduced tolerances compared to those in accordance with VDE regulations, the calculation of the short-circuit current may be based on these reduced tolerances. If measurement values are available, the calculation may be based on these values.

4.2.2 Monitoring and protection of the transformers

(1) The transformers shall be provided with monitoring devices whose displays and alarms will make it possible to determine the functional operability, the operating state and the exceeding of limit values. The monitoring equipment includes, e.g., local oil level display, temperature monitoring and Buchholz relay (oil level and gas production).

(2) Protective features shall be provided which register faults within the transformers and which effect any necessary protective disconnection or shutdown. The protective features include, e.g., the overcurrent and short-circuit protection, the transformer differential-voltage protection as well as the Buchholz protection (oil flow).

(3) The arrangement of the monitoring and protective features shall comply with the requirements of operation, maintenance and repair.

4.2.3 Suitability of the emergency-power distribution transformers

(1) The suitability of the emergency-power distribution transformers for use in nuclear power plants shall be demonstrated by type approval tests and proof of successful operating experience.

(2) A transformer may be assumed to be suitable if:

a) a type approval test of a transformer of this production batch has been successfully performed as specified in Section 5.2.2,

and

b) the successful operating experience of 10 transformers of an individual production batch can be proven over a period of at least three years of operation under comparable operating conditions.

Note:
Transformers belong to an individual production batch if they are constructed along the same design principle, even though they may, individually, differ with respect to their rating (power, transformer ratio, short-circuit voltage).

(3) In the case of indications of overloaded components, of wrongly selected materials or of other common-mode failures, a proof that the cause of failure has been removed shall be presented.

(4) If the transformer to be used in the nuclear power plant has individual components which differ from those of the production batch used in the proof of successful operating experience, a separate suitability test on those components is permissible, however, only in substantiated cases.

(5) If the deployment in nuclear power plants requires additional safety-related properties, e.g., a design against loads from external events, and if these properties are not covered by the proof of successful operating experience and by the type approval tests as specified under Section 5.2.2, additional suitability demonstrations shall be performed.

(6) Kind and scope of the suitability tests indicated in paras. 4 and 5 shall be specified in agreement with the authorized expert (under Sec. 20 Atomic Energy Act).

4.3 Emergency-Power Distribution Network

4.3.1 Design of cables, lines, busbars, terminal and connecting elements

(1) Taking the required functions into account, the cables, lines, busbars, terminal and connecting elements shall be designed to withstand the most unfavorable ambient conditions at their individual locations, and they shall meet the superordinate requirements specified under Section 3.

Note:
Terminal and connecting elements include cable lugs, end seals, sleeve couplings, cable clamps, plug-in connectors, plug-and-socket assemblies and auxiliary terminal boxes.

(2) Only those components shall normally be used that have been designed, fabricated and tested in accordance with VDE regulations or DIN standards.

(3) Components of the emergency-power distribution network which are deployed in the controlled-access area shall normally have a surface finish that can be decontaminated.

(4) With respect to the type of insulation materials and to the physical arrangement, cables, lines, busbars and the terminal and connecting elements shall be chosen such that during their specified service life no changes will occur which are impermissible with regard to functional capability. In this context, the ambient temperatures and, if applicable, radiation exposure during specified normal operation as well as, if applicable, any additional stresses under loss-of-coolant accident conditions (e.g., from temperature, humidity, radiation) shall be taken into consideration. The thermal and mechanical short-circuit resistance shall basically be determined on the basis of the maximum short-circuit currents and the short-circuit duration specified for the final location (exception: see para. 5 item b).

(5) The conductor cross sections shall be dimensioned to meet, in particular, the following requirements:

a) The conductor temperatures specified for the individual insulating material as being permissible during continuous operation and for a short period only shall not be exceeded.

   The values of the maximum permissible current capacity shall be further reduced if the power cables are routed in multiple layers. The current capacity thus determined shall be at least equal to the maximum current during continuous operation.

b) With regard to short-term thermal stressing, the maximum thermally effective short-circuit current and the short-circuit duration until a disconnection or shutdown is effected the closest switching unit shall be assumed. In designing the conductor cross-section, it is not required to consider the longer short-circuit duration which would result if the protective disconnection of the short-circuit current were performed by the standby protection.

c) Considering the anticipated cable length and its source impedance, the loop resistance shall be limited to such a value that neither the permissible voltage drop in case of a continuous current nor the permissible voltage dip in case of a startup of motors or groups of motors will be exceeded. In addition, it shall be ensured that the minimum short-circuit current will trigger the protective features within the permissible protective disconnection or shutdown time.

(6) The terminal and connecting elements of those cables connected to cable penetrations through the containment vessel shall withstand the maximum loads at their individual final location.

Note:
Requirements for the cable penetrations through the reactor containment vessel are specified in safety standard KTA 3403.

4.3.2 Design of cable tray systems

(1) Cable tray systems shall be designed to meet the requirements resulting from the mechanical and electrical loads and from the given structural conditions.

Note:
The cable tray systems include cable clamps for the individual routing of cables and lines and, if necessary, the cable conduits at mechanically hazardous locations, as well as cable racks, cable grates or cable troughs for the mutual routing of cables and lines.

(2) The essential design requirements are the following:

a) The maximum weight of the cables as well as the additional weights and forces during assembly shall be absorbed by the cable tray system and the elements that fasten it to the building structures.

b) Insofar as applicable in individual cases, loads from the anticipated induced vibrations shall, additionally, be absorbed.

c) The bending radii of the cables and lines shall not be smaller than the permissible limit values.

d) A sufficient heat dissipation shall be ensured for the cables and lines.

e) Cable tray systems in the controlled-access area shall be such that they can be decontaminated.

f) Cable tray systems from metallic materials shall be included in the grounding and potential grading measures.

g) The cable tray system shall permit carrying out the necessary separation of high-voltage cables from low-voltage power cables and the separation of power cables from cables of the instrumentation and control system.

4.3.3 Monitoring and protecting the emergency-power distribution network

(1) If plug-in connections are used for electrical power loads, a disconnection of these plug-in connections shall normally be identifiable in the main control room.

(2) The protective features specified in Section 4.1.2 para. 5 shall be provided.

4.3.4 Suitability of the emergency-power distribution network

(1) The suitability of the cables, lines, busbars and terminal and connecting elements as well as of the cable tray systems of the emergency-power distribution network to be deployed in nuclear power plants shall be demonstrated by the type approval tests specified in Sections 5.2.3 and 5.2.4.

(2) It is permissible to demonstrate the suitability for an individual production batch.

Note:

Cables, lines, busbars and terminal and connecting elements belong to an individual production batch if they are constructed along the same design principle and with similar materials, even though they may, individually, differ with respect to the number of conductors and the gradation of cross sections.

(3) If components are used which have not been designed, fabricated and tested in accordance with VDE regulations or DIN standards, the kind and scope of the suitability demonstration shall be specified in agreement with the authorized expert (under Sec. 20 Atomic Energy Act).

4.4 Arrangement and Installation

(1) The location and arrangement of the switchgear compartments and of the cable routes, the installation of the switchgear, distribution transformers and components of the emergency-power distribution network shall be such that the requirements with respect to protection against external events, to redundancy, functional independence and physical separation are met.

(2) The switchgear shall normally be installed in closed electrical operations facilities (switchgear compartments) and such that, with special regard to operation, maintenance and repair, they are clearly arranged and easily accessible.

5 Component-Specific Test Requirements

5.1 Required Documents

(1) The documents to be submitted for examination by authorized experts (under Sec. 20 Atomic Energy Act), shall be sufficient prove that the planned emergency-power switchgear, emergency-power distribution transformers and components of the emergency-power distribution network, including protection features and monitoring equipment, are designed, fabricated, assembled and tested in accordance with the safety-related requirements.

(2) Test schedules shall be submitted which indicate the kind and scope of intended tests, the testers and the participation of experts. The test schedules shall be specified in agreement with the authorized expert (under Sec. 20 Atomic Energy Act).

(3) Evidence of performing the tests in accordance with Sections 5.2, 5.3.1, 5.3.2, 5.4 and 5.5 shall be submitted to the authorized expert (under Sec. 20 Atomic Energy Act).

5.2 Type Approval Tests

5.2.1 Type approval tests of emergency-power switchgear

(1) In the case of switchgear handling nominal voltages above 1 kV, it shall be demonstrated that the type approval tests have been performed on each type of switchgear. In the case of metal-clad factory built switchgears, the resistance to interfering electrical arcs shall, additionally, be demonstrated.

(2) In the case of switchgear handling nominal voltages up to and including 1000 V, it shall be demonstrated that type approval tests have been performed on each type of switchgear. In this context, the temperature during the temperature-rise test of the connectors for PVC cables and PVC lines shall not exceed the limit value of 80 °C.

(3) For the individual built-in components, e.g. switching devices and protective features, it shall be demonstrated that type approval tests in accordance with VDE regulations have been performed.

(4) If required for the particular application, it shall be demonstrated that the switchgear, within their specified requirements (stability, functional capability), will withstand the anticipated induced vibrations. An analytical verification is permissible regarding the structural frame of the switchgear. For individual components, e.g., the power breakers and protective features, experimental demonstrations shall normally be performed with respect to their functional capability under vibration-induced loads. A proof of resistance to induced vibrations is not required for the wiring and cabling within the switchgear. Vibration tests on other switchgear that is comparable with regard to its vibrational behavior may be used in this demonstration.

5.2.2 Type approval tests of emergency-power distribution transformers

(1) It shall be demonstrated that the type approval tests have been performed on each type of transformer.

(2) If required for the particular application, it shall be demonstrated that the transformers, within their specified requirements (stability, functional capability), will withstand the anticipated induced vibrations. An analytical verification shall basically be sufficient for transformers. In the case of individual devices with moveable parts (e.g., Buchholz relays, controllers), experimental demonstrations shall normally be performed regarding their functional capability. Vibration tests on other transformers that are comparable with regard to its vibrational behavior may be used in this demonstration.

5.2.3 Type approval tests of cables, lines, busbars, terminal and connecting elements

(1) Type approval tests shall be performed to demonstrate that the specified properties have been achieved. Type approval tests performed in accordance with VDE regulations may be used as demonstration of the properties specified in these VDE regulations.

(2) If specific safety-related properties are required with regard to a deployment in the safety system (e.g., resistance to loss-of-coolant accidents) and these are not covered by the type approval tests as specified in para. 1, then additional type approval tests shall be performed.

(3) If required by the particular application, it shall be demonstrated that the busbars and auxiliary terminal boxes, within their specified requirements (stability, functional capability), will withstand the anticipated induced vibrations. This demonstration may be performed analytically or experimentally. A proof of resistance to induced vibrations is not required for the wiring and cabling within the switchgear. Vibration tests on other busbars and auxiliary terminal boxes that are comparable with regard to its vibrational behavior may be used in this demonstration.

5.2.4 Type approval tests of cable tray systems

(1) It shall be demonstrated on all planned types of cable tray systems that the specified design requirements are met.

(2) In this context, the demonstration that the systems have been designed against induced vibrations may be based on analytical procedures, on experimental procedures, on analogy and plausibility considerations – either individually or in combination with one another.

5.3 Production Tests

5.3.1 Production tests on emergency-power switchgear

(1) In the case of switchgear handling nominal voltages above 1 kV, it shall be demonstrated that production tests have been performed on each individual switchgear.

(2) In the case of switchgear handling nominal voltages up to and including 1000 V, it shall be demonstrated that the production tests have been performed on each individual switchgear.

(3) For the individual built-in components, e.g. switching devices and protective features, it shall be demonstrated that type approval tests in accordance with VDE regulations have been performed.

5.3.2 Production tests on emergency-power distribution transformers

It shall be demonstrated that the production tests have been performed on each individual transformer.

5.3.3 Production tests on components of the emergency-power distribution network

The manufacturer shall perform production tests within the framework of quality assurance. A certification of these tests is not required.

5.4 Tests during Assembly at the Construction Site

Tests shall be performed during assembly at the construction site to demonstrate that those assembly conditions and assembly dimensions are adhered to that are important to the reliable functioning of the emergency-power switchgear, of the emergency-power distribution transformers and of the components of the distribution network supplying power to the safety system. These tests comprise, essentially:

a) The components shall be visually inspected with regard to their identity with the associated documents and to damages from transport, storage and assembly.

b) A test shall be performed to verify that the assembly was carried out in conformance with the valid documents, e.g., component arrangement drawing.

c) It shall be checked that the assembly instructions were followed.

d) The alignment and the mounting shall be checked.

e) The ground connection and the ground conductor connection shall be visually inspected.

5.5 Commissioning Tests

(1) Commissioning tests shall be performed on the emergency-power switchgear and the emergency-power distribution transformers. These tests comprise, essentially:

a) The insulation resistance shall be tested.

b) The function of the switching devices shall be tested.

c) The function of the monitoring devices and protective features shall be tested.

d) The interlocks shall be tested.

(2) Commissioning tests shall be performed on the circuits of the emergency-power distribution network. These tests comprise, essentially:

a) The insulation resistance shall be tested.

b) The protective measures shall be tested.

c) The loop resistance of the low-voltage cable connections between the switchgear feeder branches and the power load connection terminals shall be determined. In this context, it shall be verified that the specified voltage drop is not exceeded.

Note:
The functional operability of the distribution network is tested within the framework of the functional tests of the connected power load.

5.6 Inservice Inspections

(1) Inservice inspections shall be carried to check whether the functional operability has been maintained. These tests shall normally not be performed simultaneously on more than one train.

(2) The testing intervals for the emergency-power switchgear and emergency-power distribution transformers shall normally be coordinated with those of the remaining equipment of the emergency power system. A testing interval of four years shall normally not be exceeded, e.g., one train per year in the case of a plant with four trains. In the case of passive components, e.g., measuring the insulation resistance of busbars, the testing interval may be increased to a maximum of eight years.

(3) The functional operability of the components of the emergency-power distribution network shall be checked within the framework of the operation or of the inservice inspection of the connected power loads.

5.7 Tests after Servicing or Repairs

(1) Following completion of servicing or repair tasks on those emergency-power switchgear, emergency-power distribution transformers or components of the emergency-power distribution network that were the cause for an interruption of the functional operability, a test shall be performed to prove that the functional operability has been restored. A functional test shall be performed that depends on the kind and extent of the parts or functions concerned, and shall be specified in agreement with the authorized expert (under Sec. 20 Atomic Energy Act),.

(2) If, in the course of servicing or repair tasks, replacement parts are used that are different from those of the original configuration, then the suitability of these parts shall be demonstrated.

5.8 Testers

(1) The type approval and production tests specified in Sections 5.2 and 5.3 shall normally be performed by the plant experts of the manufacturer or under their responsibility. Authorized experts (under Sec. 20 Atomic Energy Act) shall be consulted in substantiated cases.

(2) The tests during assembly at the construction site specified in Section 5.4, the commissioning tests specified in Section 5.5, the inservice inspections specified in Section 5.6 and the tests after servicing or repairs specified in Section 5.7 shall be performed by expert personnel appointed by the licensee. If so specified in the testing schedule, authorized experts (under Sec. 20 Atomic Energy Act) shall be consulted.

5.9 Test Certificates

(1) The tests performed shall be documented by certificates. These test certificates shall contain all data necessary for the evaluation and assessment of the tests. This data includes:

a) organization performing the test,

b) test object,

c) extent of the test,

d) type of test,

e) identification number of the test instruction or, if applicable, of the standard test instruction,

f) performance of test (e.g., the specified and the actual calendar dates, testing interval),

g) test results (e.g., test objective attained, deviations, measures taken or still required),

h) confirmation of the performance of the test, of the results and of the assessment by a signature of the tester and also by that of the expert if the authorized expert (under Sec. 20 Atomic Energy Act) participated in the test.

(2) In the case of type approval tests and production tests of series-produced items, collective test certificates or non-removable test marks on the devices shall be considered as sufficient evidence that the tests have been properly performed. If series-produced items are subject to in-process surveillance and type approval tests and this is evidenced on the item by a corresponding VDE test mark, then this test mark shall be considered as sufficient evidence of a properly performed type approval test and production test.

6 Operation, Servicing and Repairs

Operation, servicing and repairs shall be performed in compliance with the instructions of the manufacturer.

Appendix A

Regulations Referred to in this Safety Standard

Regulations referred to in this safety standard are valid only in the versions cited below. Regulations which are referred to within these regulations are valid only in the version that was valid when the latter regulations were established or issued.

Atomic Energy Act		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act) of December 23, 1959 (BGBl I, p. 814) in the version of July 15, 1985 (BGBl I, p. 1565), most recently changed by Act of August 12, 2005 (BGBl I, p. 2365)
DIN EN 60076-5 VDE 0532-76-5	(2004-11)	Power transformers – Part 5: Ability to withstand short-circuit (IEC 60076-5:2000, Deutsche Fassung DIN EN 60076-5:2004)
DIN EN 60909-0	(2002-07)	Short-circuit currents in three-phase a.c. systems Part 0: Calculation of currents (IEC 60909-0:2001); German version EN 60909-0:2001
DIN EN 62271-200 VDE 0671-200	(2004-10)	High-voltage switchgear and control gear – Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200:2003); German version EN 62271-200:2004 ATTENTION: It is permissible to also apply DIN EN 60298 (1998-05), DIN EN 60298 Correction 1 (1999-03) and DIN EN 60298 Correction 2 (2001-09) , however, only until 2007-02-01.