Safety Standards

of the

Nuclear Safety Standards Commission (KTA)

KTA 2101.3 (2015-11)

Fire Protection in Nuclear Power Plants
Part 3: Fire Protection of Mechanical and Electrical Plant Components

(Brandschutz in Kernkraftwerken
Teil 3: Brandschutz an maschinen- und elektrotechnischen Anlagen)

The previous version of this safety standard was issued in 2000-12

If there is any doubt regarding the information contained in this translation, the German wording shall apply.

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KTA SAFETY STANDARD

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PLEASE NOTE: Only the original German version of the present safety standard represents the joint resolution of the 35-member Nuclear Safety Standards Commission (Kerntechnischer Ausschuss, KTA). The German version was made public in Bundesanzeiger (BAnz) of January 8, 2016.
Copies of the German versions of KTA safety standards may be mail-ordered through Wolters Kluwer Deutschland GmbH (info@wolterskluwer.de). Downloads of the English translations are available at the KTA website: www.kta-gs.de

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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 admissible method within the scope of the present 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 - AtG) in order to attain the protective goals specified in AtG and the Radiological Protection Ordinance (StrlSchV) and further detailed in the Safety Requirements for Nuclear Power Plants (SiAnf) and the SiAnf-Interpretations.

(2) The Safety Requirements for Nuclear Power Plants (SiAnf) Appendix 3 “Internal and external events as well as external hazards” states among others that protective measures against fires inside the nuclear power plant must be provided. The basic requirements regarding fire protection measures are detailed in the safety standard KTA 2101.1. The fire protection of structural components is detailed in safety standard KTA 2101.2 and the fire protection of mechanical and electrical components in the present safety standard. All three parts of the safety standard series KTA 2101 must be considered in the planning and execution of fire protection measures.

Note:

The additionally relevant KTA safety standards are specified in safety standard KTA 2101.1.

(3) The present safety standard is prepared based on the assumption that the building codes, fire protection laws and fire protection regulations of the individual German states (Länder), the German Workplace Ordinance, the German Accident Prevention Regulations (UVV) of the trade unions and other public law regulations are complied with. If the specifics of the nuclear power plant require deviations from laws, ordinances or other public law regulations or from the German Accident Prevention Regulations (UVV), then, in each individual case, the particular procedures specified in these regulations regarding deviations and exemptions must be followed.

1 Scope

This safety standard applies to nuclear power plants with light water reactors.

Note:

Further scope-related specifications are detailed in safety standard KTA 2101.1.

2 Definitions

Note:

Applicable definitions are specified in safety standard KTA 2101.1.

3 Fire Protection Measures for Mechanical and Technical Components and Facilities

3.1 General Requirements

Insofar as the measures specified under Sections 3.2 and 3.3 cannot be applied to the extent necessary to ensure the required protection in the event of fire, additional measures shall be specified regarding fire detection (e.g., by installing additional fire detectors) and regarding firefighting (e.g., by installing stationary fire extinguishing systems).

3.2 Fire Prevention Measures

3.2.1 Components containing combustible liquid or gaseous materials

(1) Hot parts in close proximity to components containing combustible materials shall basically be avoided. If this is not possible due to system-technological or usage-related requirements, measures shall be introduced to avoid an ignition of leakages (e.g., thermal insulation, double concentric pipe, encapsulation, local extraction).

(2) Oil and fuel supplies shall be designed such that their fluids cannot leak onto any plant components with a surface temperature higher than 200 °C.

(3) The systems containing combustible liquid or gaseous operating materials shall normally be provided with equipment for leakage detection (e.g., filling level monitors in case of liquid materials, pressure monitors in case of gaseous materials) and, if applicable, for the draining of leakages.

(4) Vessels containing larger amounts of combustible fluids shall be provided with collecting facilities. The volume of the collecting facilities shall be specified considering the maximum possible non-isolatable leakage amount of the largest individual vessel and, in the case of stationary water-based fire extinguishing systems, also of the accumulated firefighting agent.

Note:

Vessels containing larger amounts are, e.g., vessels of the external oil supply as well as the fuel oil tanks of the emergency power generating facilities.

(5) Combustible materials escaping from safety valves shall be safely drained off.

(6) It is not admissible to use cutting ring fittings for pressure-retaining pipes containing combustible liquid or gaseous materials.

3.2.2 Pumps

(1) In the case of an external lubricant supply, the amount of oil from leakages shall be minimized. In this context, measures for monitoring the oil level or oil pressure shall be provided. As soon as the amount of supplied oil falls below a minimum value to be specified, the oil supply shall automatically be shut off.

(2) In the case reactor coolant pumps and associated motors are provided with an integrated oil supply, the pumps shall be equipped with a collecting facility for the entire oil amount of the largest individual supply vessel.

(3) In the case of integrated oil supplies with cooling equipment inside the oil tank, the level in the oil tank shall be monitored. When the maximum admissible level is reached, the cooling water supply to the oil cooler shall be shut off.

(4) The oil supply lines of the reactor coolant pumps shall be designed against external events considering safety standard KTA 2101.1 Sec. 3.3. This shall basically also apply to the oil tank including the auxiliary equipment. In the case of an external oil supply, the oil tank including the auxiliary equipment in the same room does not need to be designed against external events, provided, it is demonstrated that the structural elements separating the firefighting sub-compartment of the oil tank compartment remain functional even after an external event and that the oil collection pan continues to be leak tight.

(5) In the case of reactor coolant pumps with an external oil supply, the design shall incorporate constructional measures that will prevent an uncontrolled release of oil.

3.2.3 Emergency power generating facilities

The fuel oil storage tank of each redundancy shall, and the fuel oil day tank of each redundant element shall normally, be located in individual firefighting sub-compartments apart from the diesel generator units.

Note:

Additional requirements regarding fire protection of emergency power generating facilities are specified in safety standard KTA 3702.

3.2.4 Turbine of a BWR

(1) The pressurized oil supply lines including the respective return lines shall be routed in separate channels to the turbine deck.

(2) The control fluid used for the turbine control system shall normally be flame retardant.

3.2.5 Gas treatment systems

(1) The design of gas treatment systems of power plants with boiling water reactors shall incorporate measures that will prevent the occurrence of a fire, that will ensure an early fire detection and that will limit the extent of the fire. In this context, the following equipment shall normally be installed:

a) at least one pre-adsorber, the size of which is limited to the operationally necessary volume of activated charcoal,

b) a carbon-monoxide detector at the exit port of the pre-adsorber, the alarm of which shall be displayed in the control room.

Note:

As specified in safety standard KTA 3904, the control room annexes are considered as part of the control room.

c) input ports for inerting gaseous fire suppression agents, and

d) individual isolating devices for the pre-adsorbers.

(2) The gas treatment systems of power plants with pressurized water reactors shall be designed such that they can be operated under a protective gas atmosphere.

(3) In the rooms of the adsorbers with activated charcoal, combustible materials are admissible only in such amounts as are necessary for the operation of these adsorbers.

(4) The vessels of adsorbers with activated charcoal filters shall be manufactured of non-combustible materials.

3.2.6 Refrigeration plants

Non-combustible refrigerants shall normally be used.

3.2.7 Storage and handling of combustible radioactive wastes, residual substances and auxiliary equipment

(1) Combustible radioactive wastes, residual substances and auxiliary equipment shall be collected in non-combustible and lockable containers. Combustible radioactive fluids shall be collected separately. The containers shall be marked with appropriate danger symbols. The containers shall normally be stored in a ventilated room until further treatment of the wastes and residual substances or until reuse of the auxiliary equipment.

(2) When storing such materials, the creation of combustible gases that can lead to an inadmissible release of radioactive materials shall be prevented, even under consideration of autoxidation. If the creation of combustible gases cannot be precluded, safety standard KTA 2103 shall be considered.

3.2.8 Insulation materials

(1) The insulation of pipes and components shall basically consist of non-combustible materials.

(2) For cold-temperature insulations it is admissible to use combustible foam isolation materials or combustible auxiliary materials, provided,

a) the insulation material is flame retardant, or

b) after installation, the insulation material used

ba) is comparable to flame retardant building materials,

bb) is protected from direct flames by a sheet metal encasement and

bc) it is proven that inside the insulation a sustained fire is not possible.

(3) In the vicinity of oil and fuel supplies, the heat insulations shall be sufficiently protected such that, in case of leakages, these fluids will not penetrate into the insulation materials. This can be achieved, e.g., by baffles or sheet metal encasements.

3.3 Measures for Limiting the Fire Impact

3.3.1 Containment vessel

(1) The containment vessel integrity shall be ensured in the event of fire. Therefore, any fire loads that could endanger the integrity of the containment vessel shall basically be avoided. Admissible exceptions are those fire loads that are protected by structural and equipment-related fire protection measures.

(2) The measures specified in para. (1) shall also ensure that heat effects on one side of the containment wall will not cause a transfer of the fire to the other side of the wall.

(3) The airlocks and airlock antechambers shall be kept free of any fire loads that are not necessary for the operation of the airlocks or for the protection of personnel.

3.3.2 Storage of combustible or combustion-promoting operating materials and of pressurized gas bottles

Note:

Requirements regarding explosion protection in nuclear power plants with light-water reactors are detailed in safety standard KTA 2103.

(1) It is not admissible to store combustible or combustion-promoting gases in areas containing safety-related plant components.

(2) The storage of combustible or combustion-promoting gases inside the controlled area shall be limited to the operationally necessary amount.

(3) The storage of combustible fluids or other combustible or combustion-promoting materials in areas containing safety-related plant components is basically inadmissible. Exempted is the storage of the amount of diesel fuel specified in safety standard KTA 3702 as well as the necessary amount of operating materials and the operating materials contained in the systems.

(4) The provision and use of combustible or combustion-promoting operating materials shall be limited to the operationally necessary amounts and time.

(5) It is not admissible to store combustible fluids together with other combustible or combustion-promoting materials.

(6) The storage or provision of pressurized gas bottles, even for non-combustible gases, in the vicinity of massive fire loads is basically inadmissible. Exempted is the provision of

pressurized gas bottles for small fire extinguishing systems and for equipment protection systems.

3.3.3 Storage for new fuel assemblies

(1) Neither the pipe lines carrying combustible materials, nor cables and power lines nor combustible materials not required for the operation of the storage facility shall be led through, or stored in, the storage room.

(2) In the storage room, only such fire suppressants shall be used for firefighting for which the criticality analysis specified in safety standard KTA 3602, Sec. 3.1.2.1, has confirmed that they will not cause criticality. The accordingly admissible fire suppressants shall be specified in the operating manual and listed at the access points to the storage room.

3.3.4 Components containing liquid or gaseous combustible or combustion-promoting materials

(1) It shall be ensured, that components containing combustible or combustion-promoting liquid or gaseous materials will not release these materials in case of fire.

(2) Basically, only non-combustible materials may be used for these components. Excepted are sealants, provided, they are protected from a direct flame exposure in the event of fire. Combustible hoses shall normally be designed to be fully metal encased.

4 Fire Protection Measures for Electrical Operating Agents and Equipment

4.1 General Requirements

(1) The proper choice of materials and protective equipment shall assure a low risk of occurrence of fire and of fire propagation in electrical equipment and their operating agents.

(2) Redundant electrical facilities and their operating agents shall be protected from each other, either by structural elements having a sufficient fire resistance capability, by their physical separation (e.g., sufficient distance) or by the encapsulation of combustible materials, such that a fire cannot lead to the failure of an inadmissible number of redundant equipment.

4.2 Terminal Boxes

Predetermined breaking points shall be arranged on the terminal boxes of high-voltage motors such that escaping gases from electric arcs are guided onto the motor housing on which the boxes are mounted.

4.3 Control Rooms and Rooms for Switch Gear and for Instrumentation and Control Equipment

(1) No cable ducts or large assemblies of cables other than those required for the function of the switch gear itself are admissible in those regions which, considering electric arc effects, are within the specified minimum distance between switch gear and the adjacent walls or plant components.

(2) Switch gear and the instrumentation and control equipment shall be housed in metal cabinets.

4.4 Cables and Cable Routing

(1) Cables and electrical conduits (“cables” for short, in the following) of the fire protection equipment for a fire compartment or firefighting sub-compartment shall basically be designed or routed such that, in the event of a fire in this fire compartment or fire sub-compartment, the function of the corresponding fire protection equipment is ensured. The only admissible exceptions are those cases where the function of the fire protection equipment has already been performed at the time of cable destruction and a later functioning of this equipment is not required anymore.

(2) The use of fire shields for cables with a shield thickness larger than 50 cm, the use of intumescent materials or cable bandages requires demonstrating that the mechanical and electrical characteristics of the cables and their connection points are maintained. The heat dissipation from the cables shall not be inadmissibly impaired.

(3) Pipe lines that are conduit to combustible materials may not be routed in cable ducts.

(4) In the case of cables that are required to counteract rapid fire propagation and that, in the event of fire, may not give off corrosive combustion gases, it shall be demonstrated that their fire behavior (e.g., low fire propagation, free of halogens, flame retardant, self-fire-extinguishing behavior, corrosiveness of the combustion gases, combustion gas density). This may be demonstrated in accordance with the standards DIN EN 50267-2-2, DIN EN 60332-3-22, DIN EN 60332-3-23, DIN EN 60332-3-24 and DIN EN 61034-2.

(5) For cables (including cable mounting elements) of systems, the function of which must be ensured even in the event of fire, a sustained function capability of the cables shall be demonstrated for the required time span.

4.5 Electric Heaters

(1) Mobile electric heaters shall be protected against inadmissible self-heating.

(2) In case electric heaters are used as stationary installations it shall be ensured that there is sufficient distance to combustible materials and that there is an unhindered dissipation of heat. In the case of mobile electric heaters this shall be ensured by administrative measures.

5 Equipment for Fire Detection and Alarm Systems

5.1 General Requirements

(1) Only certified components shall be used for the fire detection and alarm systems. The proper interaction of all components shall be demonstrated by system approvals.

(2) If fire detection and alarm systems are located inside structural components which, due to their safety-related significance, must be designed against a design basis earthquake that has an intensity, I, higher than VI (EMS-98 – European Macroseismic Scale), then these fire detection and alarm systems shall normally be designed as specified in safety standard KTA 2201.4 with the earthquake effects to be determined as specified in safety standard KTA 2201.1.

(3) Fire detection and alarm systems, the function of which must be ensured after event combinations as specified in safety standard KTA 2101.1, Sec. 3.3, shall be designed for the effects from the events to be combined. If the event combination involves an earthquake with subsequent fire and the design basis earthquake has an intensity, I, higher than VI (EMS-98), then these fire detection and alarm systems shall be designed as specified in safety standard KTA 2201.4 for the earthquake effects determined as specified in safety standard KTA 2201.1.

5.2 Transmission Routes, Detector Groups

(1) Each redundancy shall be equipped with its individual detector group. A failure affecting multiple redundancies of the detector groups shall be prevented by a corresponding arrangement and design of the transmission routes.

(2) If stationary fire extinguishing systems are triggered by automatic fire detectors, then the actuation of each fire extinguishing system in its fire extinguishing area requires a two-out-of-two dependency of the detector alarms.

(3) The fire detectors of a specific detector group shall normally all be placed either inside or outside of the permanent exclusion areas in accordance with StrlSchV.

(4) Measures shall be taken to ensure that those fire alarms from areas that are inaccessible during specific operating conditions will not become inoperative due to operational effects (e.g., radiation) until the next possible accessibility.

Note:

This can be ensured by shielding the fire detectors, by installing aspirating smoke detectors, or by multiple available detector groups.

5.3 Extent of Fire Detectors and their Arrangement

(1) The scope of protection of the fire detection and alarm system shall basically be classified as Category 1 in accordance with DIN 14675 (Full Protection). For those areas that shall not be monitored, the admissibility shall be demonstrated by a fire hazard analysis.

(1) Automatic fire detectors are required in the following areas or in areas with the following equipment:

a) switch gear, dc-dc converters,
b) cabinets for instrumentation and control equipment,
c) telecommunications centers,
d) process computers,
e) transformers located in structural components,
f) stationary battery facilities,
g) diesel units including the fuel oil supply,
h) large assemblies of cables (e.g., cable cellars, cable ducts, cable wells, conduit rooms, cable floors),
i) not-continuously-manned control stations (this includes, e.g., the areas behind the control panels, furthermore, the local control stations, the remote shutdown station and the control room annexes),
j) storage for new fuel assemblies,
k) area for the storage and handling of combustible radioactive wastes in the waste storage facility,
l) other areas for the storage of combustible materials, e.g., fuel oil depot,
m) decontamination room,
n) hot workshop,
o) oil-lubricated components with an oil reservoir or oil supply system (e.g., on the turbo-generator set in BWR, on the reactor coolant pumps, on the feed water pumps, on the main condensate pumps, on the safety injection pumps, on the high-pressure feed pumps),
p) central air conditioning facilities including, if applicable, filter compartments and air ducts of air-recirculation systems,
q) other important and fire endangered rooms that are inaccessible during plant operation.

(3) Rooms equipped with sprinkler facilities shall be monitored by automatic fire detectors.

(4) In the case of room areas monitored by automatic fire detectors for the control equipment of fire extinguishing systems, it is admissible to dispense with additional monitoring by the fire detection and alarm system. However, at least one of these automatic fire detectors in each detector group shall submit their fire and malfunction alarms also to the local fire alarm center. The necessary components of the control equipment necessary for fire detection and alarm shall meet the requirements of Section 5.1.

(5) The number and arrangement of manual fire detectors (not the automatic fire detectors) shall be specified for each individual case.

5.4 Arrangement of the Local Fire Alarm Centers, of the Display and Control Panels

(1) At least one display and control panel of the fire detection and alarm system shall be installed in the control room or in a room directly accessible from the control room.

(2) One display and control panel shall additionally be installed in the remote shutdown station. This control and display panel shall display at least the fire and malfunction alarms of the detector groups that monitor plant regions containing equipment of the emergency systems.

(3) If the display and control panels of the local fire alarm centers are installed in a room directly accessible from the control room, then one optical and one acoustical group alarm each shall be shown in the control room signaling malfunction of the fire detection and alarm system or a fire. A failure of a display and of a control panel shall be displayed in conjunction with the malfunction group alarm.

(4) In the case of a serial display of the fire alarms, the group display shall be supplemented by an additional summaric display serving as information on the queued alarms.

(5) In order to increase availability, the fire detection and alarm system shall normally comprise a network of decentralized fire alarm centers. The fire and malfunction alarms shall be transmitted to the superordinate fire alarm center via two transmission routes that shall be independent of each other.

(6) Malfunctions in local fire alarm centers shall not lead to a simultaneous erroneous actuation of fire protection equipment in different redundancies unless it is demonstrated that erroneous actuations are harmless from the standpoint of safety.

(7) Two copies of the floor plans shall be made available in the control room showing the alarm areas, the location of the automatic and non-automatic detectors, the access routes and locations of firefighting equipment. Furthermore, instructions for the correct behavior in case of fire alarms as well as descriptions regarding malfunctions of the fire detection and alarm system shall be provided. Regarding the detector groups specified under para. (2), one copy of these floor plans shall be provided in the remote shutdown station.

Note:

The tactical mission data for the fire department is contained in the deployment plans for the fire department as specified in safety standard KTA 2101.1.

(8) In case the fire alarms require manual measures, then the displays of the fire detection and alarm system, the floor plans and instructions specified under para. (7) shall be ergonomically coordinated such that a fast and unambiguous identification of the affected regions and the actuating elements of the control equipment is possible.

5.5 Arrester Systems for Fire Barriers

(2) The arrester systems of those fire barriers that must be kept open for safety-related reasons shall meet the following additional requirements:

a) The power for the arrester systems shall normally be supplied from the uninterruptible emergency power supply facility.

b) In case an uninterruptible emergency power supply is not used, then possible power interruptions (e.g., during a bus switch-over or during diesel start-up) shall be bridged

by an energy storage system such that this interruption will not lead to an actuation of the arrester system in the time span until emergency power is again effective. Other functions shall not be affected by this energy storage system.

c) The position “NOT OPEN” of the fire barriers shall be signaled as specified in safety standard KTA 2101.1, Sec. 5.5.

6 Firefighting Equipment

6.1 General Requirements

(1) The equipment for firefighting include

a) the firefighting water supply,

b) the fire extinguishing systems,

c) the mobile fire extinguishing equipment.

(2) Firefighting equipment, the function of which must be ensured after event combinations as specified in safety standard KTA 2101.1, Sec. 3.3, shall be designed for the effects from the events to be combined. If the event combination involves an earthquake with subsequent fire and the design basis earthquake has an intensity, I, higher than VI (EMS-98), then this firefighting equipment shall be designed as specified in safety standard KTA 2201.4 for the earthquake effects determined as specified in safety standard KTA 2201.1.

6.2 Firefighting Water Supply

6.2.1 General requirements

(1) The design of the pumps and dimensions of the firefighting water main loop system shall be based on the firefighting water demand (i.e., 100%) which results from the stationary fire extinguishing system with the largest as-designed water supply inside or outside of the buildings (e.g., sprinkler systems, spray-water or foam firefighting systems) plus an added water demand of 1600 liters/min (e.g., for hydrants and wall hydrants). The overall supply of available water shall allow a flow rate of at least 3200 liters/min.

(2) With the exception of the coolant water intake civil structure as well as cable and pipe penetrations, any structural components containing equipment of the safety system or of the emergency systems shall be connected to the firefighting water main loop system by at least two connection point. Each connection point to the firefighting water main loop system shall be equipped with an isolation device to allow interrupting the supply from the firefighting water main loop system on the inside of the structural component.

(3) The dimensions of these connection points shall be based on the valve station of the fire extinguishing system inside the structural component with the largest as-designed water flow rate plus an added amount of 800 l/min.

(4) In case the firefighting water is supplied entirely from tanks or firefighting water pools, the following requirements shall be met:

a) The supply shall cover the firefighting water demand (100%) specified under para. (1) for the duration of at least one hour.

b) The useable water supply shall, however, amount to at least 600 m³.

c) If the water is supplied entirely from tanks, the number and capacity of these tanks shall be such that 100% of the water supply specified under items a) and b) will be available even if one tank is unavailable.

d) In case of specified normal operation of the firefighting water supply system, it shall be possible for the water supply (100%) to be refilled within 8 hours.

(5) With regard to creating an additional firefighting water supply for mobile firefighting, firefighting water removal points for fire pumps of the fire department shall be installed at suitable locations (e.g., water intake structure, cooling tower dish). From this location it shall be possible to create a connection to the supply inlet of the firefighting water main loop system.

(6) In structural components containing equipment of the safety system or of the emergency systems, additional feed-in possibilities for mobile firefighting (800 l/min) shall be installed to enable the fire department to provide firefighting water in case of a failure of the outside firefighting water supply system.

(7) The pipe system of the firefighting water supply system shall basically be designed for the firefighting water quality available at the plant site. Alternatively, the pipe system in its operationally readied state may be filled with water that shall be harmless to the pipe system with respect to corrosion.

(8) If the pipe system of the fire extinguishing system is not designed for the firefighting water quality available at the plant site and in its operationally readied state is, therefore, filled with water that shall be harmless to the pipe system with respect to corrosion, then the following requirements shall be met:

a) Regarding fire drills of the plant fire brigade that include tapping firefighting water from the firefighting water main loop system, a firefighting water flow rate of 600 liters/min shall be sustained for at least 15 min. During fire drills it should be avoided that river water or water of a similarly low quality gets into the pipe system of the firefighting water supply.

b) In the case that, during a firefighting mission or for other reasons, river water or water of a lower quality has gotten into the pipe system, then the affected pipes, branches, valves, fittings and nozzles shall be flushed and subsequently refilled with water that shall be harmless with respect to corrosion.

(9) Any suspended matter contained in the water shall not cause functional disturbances in the firefighting water supply.

Note:

This can be achieved by flushing the firefighting water supply lines.

(10) The use of water wells as firefighting water supply is admissible, provided, their silting is prevented.

Note:

This can be ensured, e.g., by a continuous operational water removal.

(11) To protect against flooding, it is admissible to install active isolating devices in firefighting water pipes leading to structural components that, under normal conditions, are closed. It shall be possible to open these active isolating devices from the control room. Proper measures shall be taken to sustain the pressure in the pipe systems that are shutoff.

(12) Given a sufficient flooding capacity, firefighting water ingress may, alternatively, be limited by correspondingly qualified instrumentation and control equipment.

(13) The retention of firefighting water shall be dimensioned in accordance with pertinent conventional guidelines and observing the protective goals.

6.2.2 Hydrants, wall hydrants

(1) Hydrants shall be installed on the plant site in the direct vicinity of the buildings with a distance between hydrants of about 60 meters but no more than 80 meters. The hydrants shall, preferably, be located close to the access points of the buildings or close to other openings that are suitable to be used for firefighting missions in the buildings. The placement of hydrants shall normally be oriented along the free movement areas for the fire department.

(2) Wall hydrants shall be suitable for operations by the fire department. They shall, preferably, be located close to the staircases and shall normally be supplied by wet supply lines.

(3) In those areas where fires of fluids are possible (e.g., turbines or areas where diesel fuel is present), the wall hydrants shall, additionally, be equipped with firefighting equipment for fires of fluids.

6.2.3 Design of the firefighting water pipe lines

(1) The firefighting water pipe lines shall be dimensioned such that, for operation of the fire extinguishing system designed for the largest as-designed water flow rate in the respective area, a flow pressure of at least 0.3 MPa is available at the most unfavorable water hydrant.

(2) The water velocity shall normally not exceed 10 m/sec in pipe lines and 5 m/sec in the valves and fittings.

(3) The firefighting water pipe lines shall be routed such that they are protected against frost.

(4) The firefighting water pipe lines shall be routed such that leakages will not adversely affect the function of more than one redundancy of the safety-related equipment.

(5) The chemical suitability of the firefighting water pipe lines as well as associated valves and fittings shall be demonstrated.

Note:

Regarding the chemical suitability in case of using river water or similar water qualities, the requirements under Section 6.2.1 para. (7) shall be considered.

6.3 Fire Extinguishing Systems

6.3.1 General requirements

(1) Stationary, automatically actuated fire extinguishing systems shall be installed for the oil-filled high-power transformers of the main off-site power connection (e.g., generator transformers) and of the auxiliary power branch-off (e.g., station transformers) specified in safety standard KTA 3701. This requirement also applies to standby mains transformers if a fire-related inadmissible impairment of adjacent buildings and facilities cannot be precluded.

Note:

Suitable for the actuation are, e.g., Buchholz relays, differential relays or temperature sensitive triggering systems.

(2) Stationary fire extinguishing systems shall normally be installed in the following rooms or in rooms with the following equipment:

a) turbine oil tanks and turbine oil channels,
b) fuel oil storage for diesel units where supply tanks and fuel oil day tanks are inside buildings,
c) reactor coolant pumps including oil tanks,
d) not encapsulated large assemblies of cables (e.g., in cable ducts, conduit rooms and cable floors),
e) not encapsulated large fire loads in areas difficult for manual firefighting (e.g., poor accessibility, high local dose rate, insufficient smoke removal),
f) waste treatment and storage of radioactive combustible materials,
g) electronic data processing facilities.

(3) The suitability of the fire extinguishing systems shall be demonstrated for the individual application. The fire extinguishing systems may basically be planned and designed in accordance with generally accepted engineering standards. Admissible exceptions are related to the actuation, power supply, firefighting water supply and tests as specified in this section.

Note:

Generally accepted engineering standards are, e.g., DIN, Comité Européen des Assurances (CEA), National Fire Protection Association (NFPA).

(4) In areas of the storage and handling of radioactive materials, precautionary measures shall be taken to prevent a spreading of radioactivity by the fire suppression agents.

(5) In the controlled area, the entire firefighting water shall be retained inside the controlled area.

6.3.2 Water-based fire extinguishing systems

(1) Stationary water-based fire extinguishing systems are, e.g.,

a) stationary and semi-stationary spray-water extinguishing systems,
b) stationary and semi-stationary fine-spray-water extinguishing-systems,
c) fogging fire extinguishing systems,
d) sprinkler systems,
e) variants of these fire extinguishing systems regarding propellant gases or inert gases.
f) foam firefighting systems.

(2) In the case of oil-containing components and systems, each individual case shall be evaluated to prove that a simultaneous actuation of multiple fire extinguishing systems in the same firefighting sub-compartment is not necessary.

(3) In the rooms and areas protected by water-based fire extinguishing systems, the fire suppression agent shall either be collected or be drained off in a controlled and harmless manner.

(4) In the case of oil fuel supply facilities protected by water-based fire extinguishing systems, the positioning area of the oil supply shall be designed such that the water-oil mixture of one fire extinguishing process shall either be collected or be drained off in a controlled and harmless manner. Measures shall be provided that the accumulated water-oil mixture of the fire extinguishing process can be drained off in a controlled way after the fire extinguishing process.

6.3.3 Gas-based fire extinguishing systems

(1) Gas-based fire extinguishing systems are, e.g.,

a) CO_2 fire extinguishing systems,
b) inert-gas fire extinguishing systems,
c) fire extinguishing systems with halogenated hydrocarbons.

(2) Any damage to the pressure vessels including associated valves and fittings of gas-based fire extinguishing systems shall not have inadmissibly adverse effects on safety-related plant components.

(3) In case of the actuation of an area-protecting fire extinguishing system, the fire extinguishing area shall be isolated. Unless other measures prevent an inadmissible pressure increase in the fire extinguishing area, the pressure relief equipment shall be kept open during the gas inflow process. To prevent the fire extinguishing gas concentration from prematurely falling below effective values, the pressure relief equipment shall be closed after termination of the gas inflow process.

Note:

An isolated fire extinguishing area is not one that is closed off in accordance with building regulations but rather one where the fire dampers or fire barriers are closed.

(4) The pressure relief related gas overflows from a fire extinguishing system may be directed into adjacent rooms or areas, provided, that this does not have any inadmissible safety-related effects, that any danger to personnel is excluded and that the enclosing structural elements of these rooms or plant areas are not inadmissibly impaired. In the case fire extinguishing systems are actuated inside the controlled area, the pressure relief related gas overflows may only be directed into rooms of the controlled area.

(5) Gas-based fire extinguishing systems for the control room and rooms directly accessible from there shall basically only be actuated manually. An automatic actuation of gas firefighting systems is admissible if the control room personnel can remain in the control room after actuation.

Note:

The protection of personnel is of utmost importance in the control room and in rooms directly accessible from there. It can be assumed that an immediate actuation of the gas-based fire extinguishing system is ensured by the personnel continuously present in the control room.

6.3.4 Controls of the fire extinguishing systems

(1) The triggering controls of the fire extinguishing systems shall be designed such that they cannot be inadmissibly impaired by the fire they are to mitigate. In the case of electrical controls, the power needed for the controls shall be ensured even if the regular power grid fails.

(2) In the case of a non-automatic actuation, it shall be ensured that actuation occurs early and reliably. The respective actuation criteria and instructions for a manual actuation of the fire extinguishing systems shall be included in the operating manual. The actuation criteria shall be specified for each individual case.

Note:

Such criteria pertain to, e.g., the triggering of the fire detection and alarm system, the visual check using the plant's television system, the failure or malfunction alarms.

(3) A manual actuation of the fire extinguishing system shall normally be provided that is independent of the remote actuation or of the automatic actuation.

(4) Preventive measures to avoid any erroneous actuation of the fire extinguishing systems shall be provided.

Note:

Such preventive measures are, e.g., in the case automatic actuations are triggered from fire detectors, the logical connection of two fire detector groups, or actuation controls that are based on the load current principle.

(5) In well substantiated cases, the effective running time of spray-water extinguishing systems may be limited to no less than 5 minutes.

(6) The actuation of a fire extinguishing system shall be annunciated in the control room as specified in safety standard KTA 2101.1, Sec. 5.5.

(7) Sprinkler systems only need to fulfill paras. (1), (4) and (6).

6.4 Mobile Fire Extinguishing Equipment

(1) Instead of portable fire extinguishers, it is admissible to also provide part of the fire suppression agent amount required in accordance with ASR A2.2 in mobile equipment (no more than 50 kg).

(2) The choice and deployment of mobile fire extinguishing equipment in electrical equipment requires the additional consideration of DIN VDE 0132.

Note:

The fire suppression agents shall be chosen taking possible impairments, e.g., to electrical and electronic components into consideration.

7 Ventilation Systems, Equipment for Heat and Smoke Removal

7.1 General Requirements

(1) To prevent the spreading of smoke, those air-recirculation systems serving more than one firefighting sub-compartment shall be equipped with smoke controls that would automatically switch the air-recirculation systems over to an external air and exhaust air operating mode. From the control room it shall be possible to reset this automatic switch-over. This requirement does not apply to the air-recirculation cooling systems in the controlled area.

(2) The fire compartment or firefighting sub-compartment concerned shall be isolated by a remotely controlled closing of the fire dampers.

(3) Those ventilation systems and the equipment for heat and smoke removal, the function of which must be ensured after event combinations as specified in safety standard KTA 2101.1, Sec. 3.3, shall be designed for the effects from the events to be combined. If the event combination involves an earthquake with a subsequent fire and an intensity of the design basis earthquake, I, higher than VI (EMS-98), then these ventilation systems and the equipment for heat and smoke removal shall be designed as specified in safety standard KTA 2201.4 for the earthquake effects determined as specified in safety standard KTA 2201.1.

7.2 Ventilation Systems

(1) Those ventilators of ventilation systems, the function of which must be ensured in the event of fire, are not required to be redundant alone for reasons of fire protection.

(2) In case ventilation systems are equipped with filter systems, it shall be ensured that they are not inadmissibly impaired by the loads from, e.g., temperature, pressure, fire by-products or fire suppression agents.

Note:

In this context and considering, e.g., the radiation exposition expected in the direct vicinity, peripheral deflectors can be provided surrounding the filter system.

7.3 Equipment for Heat and Smoke Removal

(1) The individual measures for heat and smoke removal as well as the required time for the removal of smoke and the required air volume flows shall be specified for each individual case dependent on the local conditions. At least the following aspects shall be considered:

a) location of the room or area,

b) possibility of air supply or air exhaust using the ventilation facilities,

c) objective of smoke removal (e.g., enabling rescue or mobile firefighting operations), or

d) restrictions for reasons of radiation protection (e.g., low external air and exhaust air volume flows).

(2) The smoke removal air volume flow may not be interrupted during in time frame specified for the removal of smoke (e.g., by the closing of fire dampers, by constrictions in mufflers, by the clogging up of filters).

(3) The inlet air volume flow required for the smoke removal shall be ensured. In the case of powered smoke removal, it is admissible that the required inlet air volume flow is also supplied from the inlet air to an air conditioning and ventilation system of the respective room. In this context, after closing the possibly provided inlet-air-oriented fire dampers, continued operation of the heat and smoke removal system is only admissible if the developing pressure differences are not inadmissibly high.

7.4 Preventing Smoke Ingress into Necessary Staircases and Airlock Antechambers

7.4.1 General requirements

(1) Smoke ingress into necessary staircases and airlock antechambers shall be prevented (e.g. by thinning down or removal of the smoke) by providing either

a) equipment for natural venting, or

b) powered airing and venting systems.

Note:

Natural venting is not suitable, e.g., in radiologically relevant regions of the controlled area, in regions without a sufficient number of openings to the outside, or where plant security requires that doors are kept closed.

(2) The opening of equipment for smoke removal in staircases of the controlled area shall be displayed and logged in the control room as specified in safety standard KTA 2101.1, Sec. 5.5.

7.4.2 Equipment for natural venting

Natural venting may basically not be used in staircase regions that are below ground level. Exception are admissible when connecting to sub-ground levels in which the smoke ingress is expected to be minimal.

7.4.3 Powered airing and venting facilities for the dilution of smoke

(1) The powered airing and venting facilities for regions outside of the inner compartments of the reactor building shall be designed such that a sufficient smoke dilution is achieved for the assumed duration of self-rescue operations. The air exchange rate shall be specified for each individual case.

Notes:

a) A self-rescue operation is generally assumed to take up to 15 minutes.

b) By the antechambers and air locks located between the fire compartment or area and the rescue route, the requirements of the powered airing and venting facilities regarding dilution of smoke may be reduced.

(2) The air flow shall be guided such that it purges the necessary staircases and airlock antechambers along their entire lengths.

(3) The supply of the amount of air required for the dilution of smoke shall be ensured by an additional ventilation system or by utilizing the air supply branched off from other areas.

(4) The opening force at the doors shall be limited such that, when deploying powered airing and venting facilities for the dilution of smoke, opening the doors does not require auxiliary means.

7.4.4 Necessary staircases and airlock antechambers inside inner compartments of the reactor building of a PWR

(1) In the event of fires inside inner compartments of the reactor building of a pressurized water reactor, the entire inlet air flow of normal operation shall, as far as possible, normally be available for the airing of staircases and airlock antechambers.

Notes:

a) The inlet air flow is limited by the fact that openings penetrating the containment must be kept small. The inlet air flow shall be specified for each individual case.

b) It is possible that ventilation systems inside the inner compartments of the reactor building must be shut off for safety-related reasons, thereby limiting the smoke dilution in the necessary staircases and airlock antechambers.

(2) During maintenance and the expected conditions inside the reactor building (e.g., unlocked and open doors of personnel airlocks, a significant increase in the number of persons), the air supply to the necessary staircases and airlock antechambers shall be increased in the event of fire. The requirements shall be specified for each individual case. In this context, limitations for reasons of radiation protection shall be considered.

(3) The necessary control actions regarding paras. (1) and (2) shall be performed from the control room.

7.5 Controls, Displays, Power Supplies

7.5.1 Controls for fire dampers and smoke exhaust dampers

(1) If fire dampers for reasons of preventing the spreading of smoke must be closed before the soft-solder triggering occurs (e.g., to protect rescue routes or to protect sensitive components), these fire dampers shall be provided with an actuation control that is independent of the soft-solder triggers.

(2) Normally, the independent actuation specified under para. (1) shall basically be triggered automatically by smoke detectors. If safety-related reasons command that an automatic actuation is inadmissible, remote actuations shall be provided at least from one well accessible local control station or from the control room.

(3) If safety-related reasons command that fire dampers are actuated only in the event of fire and must, otherwise, remain in the “OPEN” position, the controls of the fire dampers shall be designed such that no erroneous actuation must be assumed (e.g., thermal actuation of the fire dampers, or triggering controls based on the load current principle), or technical administrative measures shall be provided by which these fire dampers can be opened within a specified time frame.

(4) In case air conditioning and ventilation systems are also employed for heat and smoke removal, it shall be ensured that, even under the room temperatures expected in case of demand, the controls of necessary fire dampers and smoke exhaust dampers is maintained.

(5) In order to prevent an unintended closing of the air inlet dampers caused by reversed currents of hot combustion gases, the controls for the smoke exhaust dampers shall be designed such that these dampers open automatically when a fire damper in the air exhaust duct closes.

7.5.2 Controls of heat and smoke removal systems

Early smoke detection and the design or arrangement of the switching and control equipment shall be such that, in case of demand, the proper functioning of the heat and smoke removal systems is ensured. This applies, particularly, to the case where components catch fire that are in the same room with the switching and control equipment.

7.5.3 Position indicators, signals

(1) Fire dampers shall send out at least the following feedback signals:

a) a feedback signal of the position of the individual fire damper which is sent to the corresponding local control station. As specified in safety standard KTA 2101.1, Sec. 5.5, corresponding group signals shall be sent from these local control stations to the control room.

Note:

The feedback signal may indicate the position of the individual fire damper (CLOSED or NOT OPEN or both). In this context, regarding ventilation aspects or explosion protection aspects may become relevant.

b) a feedback signal of the individual fire damper which is sent to the control room – required in case further measures are to be performed by the control room personnel.

(2) At least the following feedback signals shall be displayed at the corresponding local control station and, as specified in safety standard KTA 2101.1, Sec. 5.5, as a group signal in the control room:

a) the operation of ventilation systems with fire protection functions, and

b) the closing of the fire protection barriers which, for reasons of ventilation, are in the open position during normal operation.

(3) The “OPEN” position of smoke exhaust dampers shall be displayed at the corresponding local control station.

7.5.4 Routing of triggering and signaling cables and of other controls-related transmission devices

(1) Cables required for triggering and feedback signaling shall basically meet the requirements specified under Section 4.4.

(2) In deviation of para. (1), it is admissible to route the cables required for feedback signaling through the room to be protected, provided, in the event of fire, no control action is derived from these feedback signals.

7.5.5 Controls for ventilators

(1) Ventilators used exclusively for keeping the rescue routes free from smoke shall be equipped with on-site controls for their manual actuation. In staircases, it shall, additionally, be possible to trigger these ventilators either remotely from the control room or automatically by smoke detectors.

(2) The local control points shall basically be located at the access points to the rescue routes and, in the case of staircases, at least at the top and bottom levels as well as at the exit level. Only one control point, namely at the exit level, is sufficient if the ventilators are automatically triggered.

(3) Ventilators used for heat and smoke removal shall be equipped with on-site controls for their manual actuation. It shall, additionally, be possible to trigger these ventilators either remotely from the control room or automatically by smoke detectors. It shall be ensured that during startup of the smoke removal ventilator the corresponding smoke exhaust damper is already open or that it can still be opened during operation of the ventilator.

(4) A buildup of inadmissible pressures (e.g., due to insufficient inlet air) that could lead to a failure of the structural elements shall be prevented.

7.5.6 Power supply

(1) A reliable power supply shall be provided for the ventilation systems and equipment under Section 7. The auxiliary power supply specified in safety standard KTA 3701, Sec. 2, para. (1), may be considered as sufficiently reliable.

(2) The ventilation systems and the equipment for heat and smoke removal specified under Section 7.1, para. (3) shall, additionally, be connected to the emergency power supply.

(3) All controls and displays of the ventilation systems and the equipment for heat and smoke removal specified under Section 7.1, para. (3) shall be connected to the uninterruptible emergency power supply.

(4) It shall be ensured for ventilation systems with specified functions in the event of fire, that the power supply (e.g., cables and their routing, including controls) is maintained for the required duration of the respective function.

7.6 Design of Special Systems or Components

7.6.1 Activated charcoal filters and high-efficiency particulate air filters

(1) Filter shells shall be constructed of non-combustible materials (cf. safety standard KTA 2101.1, Sec. 3.2.1 para. (3)).

(2) Tightly closing ventilation dampers shall be arranged before and after filter units with activated charcoal. These ventilation dampers shall be designed to be triggered from the control room. Smoke detectors shall be installed in the duct on the inlet air side of the first ventilation damper. A fire damper shall be installed before the filter if smoke temperatures above 100 °C can occur due to local conditions (e.g., duct length, mixture temperature, fire load, ingression of fire).

(3) If the exhaust air system is used for the removal of smoke then it shall be possible to bypass the activated charcoal filters and high-efficiency particulate air filters.

(4) In order to be able to detect a fire in the activated charcoal filters, alarm devices (e.g., carbon monoxide measuring devices) shall be installed between the filters and ventilation dampers. The alarms shall be displayed in the control room.

Note:

In non-flow-through filter systems, a buildup of the carbon monoxide concentration that can lead to false alarms must be expected.

(5) In rooms housing activated charcoal filters and high-efficiency particulate air filters, combustible materials are admissible only in such amounts as are required for regular operation of these filters and ventilation systems.

(6) Requirements for mobile filter systems shall be specified for each individual case.

7.6.2 Accident filtration systems

(1) It is not admissible to use accident filtration systems (exhaust-air filtration facilities as specified in safety standard KTA 3601, Sec. 5.2.3) for the removal of smoke. The requirements specified under Section 7.6.1, paras. (2) through (4) do not apply to accident filtration facilities.

(2) Safety-related reasons command that accident filtration systems that are triggered by the reactor protection system may not be equipped with fire dampers. In these cases, a fire and smoke transmission into other fire compartments shall be prevented by a proper type and routing of the ducts.

Note:

The thick-walled air ducts penetrating through structural plant components with fire protection functions may be protected by enclosing the ducts with fire shields like those used for fire-protected steel pipe penetrations.

Appendix A

Regulations Referred to in the Present Safety Standard

(Regulations referred to in the present 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.)

AtG		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act – AtG) of December 23, 1959, revised version of July 15, 1985 (BGBl. I, p. 1565), most recently changed by Article 307 of the Act of August 31, 2015 (BGBl. I 2015, No. 35, p. 1474)
StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance – StrlSchV) of July 20, 2001 (BGBl. I, p. 1714; 2002 I, p. 1459), most recently changed by Article 5 of the Act of December 11, 2014 (BGBl. I, p. 2010)
SiAnf	(2015-03)	Safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B2)
SiAnf Interpretations	(2015-03)	Interpretations of the safety requirements for nuclear power plants of November 22, 2012, revised version of March 3, 2015 (BAnz AT of March 30, 2015 B3)
KTA 2101.1	(2015-11)	Fire Protection in Nuclear Power Plants; Part 1: Basic requirements
KTA 2101.2	(2015-11)	Fire Protection in Nuclear Power Plants; Part 2: Fire Protection of Civil Structures
KTA 2103	(2015-11)	Explosion Protection in Nuclear Power Plants with Light Water Reactors (General and Case-Specific Requirements)
KTA 2201.1	(2011-11)	Design of Nuclear Power Plants Against Seismic Events; Part 1: Principles
KTA 2201.4	(2012-11)	Design of Nuclear Power Plants Against Seismic Events; Part 4: Components
KTA 3601	(2005-11)	Ventilation Systems in Nuclear Power Plants
KTA 3602	(2003-11)	Storage and Handling of Fuel Assemblies and Associated Items in Nuclear Power Plants with Light Water Reactors
KTA 3701	(2014-11)	General Requirements for the Electrical Power Supply in Nuclear Power Plants
KTA 3702	(2014-11)	Emergency Power Generating Facilities with Diesel-Generator Units in Nuclear Power Plants
KTA 3904	(2007-11)	Control Room, Remote Shutdown Station and Local Control Stations in Nuclear Power Plants
DIN 14675	(2012-04)	Fire detection and fire alarm systems - Design and operation
DIN EN 50267-2-2 VDE 0482-267-2-2	(1999-04)	General testing procedures for the behavior of cables and insulated conduits under fire conditions – Testing the gases created when burning the materials of cables and insulated conduits – Part 2-2: Test procedures; Determining the acidity level of the gases from the materials by measuring their pH value and conductivity German version EN 50267-2-2:1998
DIN EN 60332-3-22 VDE 0482-332-3-22	(2010-08)	Tests on electric and optical fiber cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A (IEC 60332-3-22:2000 + A1:2008); German version EN 60332-3-22:2009
DIN EN 60332-3-23 VDE 0482-332-3-23	(2010-08)	Tests on electric and optical fiber cables under fire conditions - Part 3-23: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category B (IEC 60332-3-23:2000 + A1:2008); German version EN 60332-3-23:2009
DIN EN 60332-3-24 VDE 0482-332-3-24	(2010-08)	Tests on electric and optical fiber cables under fire conditions - Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category C (IEC 60332-3-24:2000 + A1:2008); German version EN 60332-3-24:2009
DIN EN 61034-2 VDE 0482-1034-2	(2014-11)	Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements (IEC 61034-2:2005 + A1:2013); German version EN 61034-2:2005 + A1:2013
DIN VDE 0132	(2015-10)	Firefighting and technical assistance in or near electrical installations
ASR A2.2	(2012-11)	Technical workplace regulations – Measures to prevent fires