Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 2101.3 (12/2000)

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)

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

Editor:
KTA-Geschaeftsstelle c/o Bundesamt fuer Strahlenschutz (BfS)
Willy-Brandt-Str. 5 • 38226 Salzgitter • Germany
Telephone +49-(0)1888/333-(0)1621 • Telefax +49-(0)1888/333-1625

KTA SAFETY STANDARD

December 2000	**Fire Protection in Nuclear Power Plants Part 3: Fire Protection of Mechanical and Electrical Plant Components**	KTA 2101.3

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. 106a on June 9, 2001. Copies may be ordered through the Carl Heymanns Verlag KG, Luxemburger Str. 449, 50939 Koeln, Germany (Telefax +49-(0)221-94373603).

All questions regarding this English translation should please be directed to:

KTA-Geschaeftsstelle c/o BfS, Willy-Brandt-Str. 5, 38226 Salzgitter, Germany

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, the 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.

Fundamentals

(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 the damage arising from the construction and operation of the facility (Sec. 7 para. 2 subpara. 3 Atomic Energy Act), in order to attain the protection goals specified in the Atomic Energy Act and Radiological Protection Ordinance (StrlSchV) and which are further detailed in "Safety Criteria for Nuclear Power Plants" and in "Guidelines for the Assessment of the Design of PWR Nuclear Power Plants against Incidents pursuant to Sec. 28 para. 3 of the Radiological Protection Ordinance (StrlSchV) – Incident Guidelines".

(2) Criterion 2.7 "Fire and Explosion Protection" of the Safety Criteria for Nuclear Power Plants specifies that protection measures shall be taken against fires in nuclear power plants. In accordance with Table II of the Incident Guidelines, plant-internal fires belong to those design basis accidents (incidents) for which precautionary plant engineering measures must be taken and which on account of these measures do not have any relevance with respect to radiological effects on the environment.

The details of these precautionary measures with respect to mechanical and electrical equipment-related fire protection measures are specified in this safety standard.

(3) In setting up this safety standard it is assumed that the building codes, fire protection laws and fire protection regulations of the individual German states (Länder), the Workplace Ordinance, the German Accident Prevention Regulations of the trade unions, the VdS guidelines and other regulations under public law are met. If the specifics of the nuclear power plant require deviations from laws, ordinances or other regulations under public law or from the German Accident Prevention Regulations (UVV), then the particular deviations and exceptions shall be handled on an individual basis in accordance with the procedures specified in those individual regulations.

(4) This safety standard KTA 2101.3 supplements the safety standards

KTA 2101.1 Fire protection in nuclear power plants;
Part 1: Basic requirements

KTA 2101.2 Fire protection in nuclear power plants;
Part 2: Fire protection of structural plant components

by additional requirements that apply specifically to the fire protection of mechanical and electrical plant components in nuclear power plants. It is closely connected to the structural requirements specified in safety standard KTA 2101.2, in particular to those specified for ventilation systems as well as cable and pipe penetration bushings.

Note:
Additional relevant KTA safety standards are listed in KTA 2101.1.

1 Scope

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

It applies to the protection from building-internal and building-external fires, in particular, with respect to

a) plant components the safety function of which are necessary to meet the protection goals on which the Safety Criteria are based, i.e.,
   aa) control of reactivity,
   ab) cooling of fuel assemblies,
   ac) confinement of radioactive substances and
   ad) limitation of radiation exposure,
b) the structural plant components which enclose these plant components and
c) the plant personnel .

N o t e :
These structural plant components include, e.g., the reactor building, the reactor auxiliary building, the nuclear services building as well as the structural plant components of the service cooling water circuits, the emergency standby building, the emergency feed water building, the switch gear building, the turbine building of boiling water reactors, the emergency power generator building, the piping and cable ducts between the aforementioned buildings.

2 Definitions

Note:
Additional definitions are given in safety standards KTA 2101.1 and KTA 2101.2.

(1) Mechanical smoke removal

Mechanical smoke removal is based on exhausts equipped with ventilators.

(2) Thermal smoke removal

Thermal smoke removal is based on exhausts that work by thermal convection.

(3) Heat and smoke removal systems

Heat and smoke removal systems (HSR) are the entirety of all equipment that normally and predominantly serve as exhaust for the smoke and hot combustion gases in the event of fire. This includes mechanical and thermal smoke removal.

3 Fire Protection Measures for Mechanical Components and Systems

3.1 General Requirements

(1) An analytical confirmation with regard to the loading from external events is required for those fire protection equipment of mechanical components that, in the course of the individual nuclear licensing procedure, are specified in conjunction with the fire protection concept.

(2) Oil supplies shall be designed such that possible leakage oil will not come into contact with plant components having a surface temperature higher than 200 °C. The heat insulation in the vicinity of oil supplies shall be designed such that autoxidation from leakage oil seeping into the heat insulation is prevented.

(3) Insofar as the measures specified under Sections 3.2 through 3.13 cannot be applied to the extent needed to ensure the required protection in the event of fire, additional measures regarding fire detection (e.g., by installing additional fire detectors) as well as regarding fire fighting (e.g., by installing stationary fire extinguishing systems) shall be specified.

3.2 Components Containing Combustible Liquid or Gaseous Materials

N o t e :
Special reference is made to VBG 61 (Gases), to the Technical Standards for Flammable Liquids (TRbF), Technical Standards for Pressure Vessels (TRB), Technical Standards for Pressurized Gases (TRG) and to Technical Standards for Acetylene Facilities and Calcium Carbide Depots (TRAC). General requirements are contained, e.g., in VGB Guideline "Fire Protection in Nuclear Power Plants" (VGB-R 108). Protective measures against explosions are specified in safety standard KTA 2103.

(1) Only non-combustible materials shall basically be used. Exceptions are permissible in the case of sealants and gaskets, provided, they are protected against direct flames in the

event of fire. Combustible hoses shall normally be completely surrounded by metal sheathing.

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

(3) Vessels containing larger amounts of flammable liquids shall be provided with collecting facilities. The volume of the collecting facilities shall be specified under consideration of the maximum possible non-isolatable leakage amount of the largest individual vessel and, in the case of the presence of a stationary fire extinguishing system, also of the accumulated fire suppressant; measures shall be taken to enable a controlled draining off of the accumulated fire suppressant and liquid leakage.

(4) Combustible materials escaping from safety valves shall be safely drained or dissipated off.

(5) Any hot component parts shall basically be avoided in the vicinity of components containing combustible or combustion supporting materials. If this is not possible for technical reasons, measure shall be taken to prevent self-ignition of the leakages (e.g., insulation, concentric guard pipe, encapsulation, air exhaust).

(6) It is not permissible to use cutting ring fittings for pressure retaining pipes containing flammable liquid materials.

3.3 Systems Containing Radioactive Substances

The necessity for a fire protection of pipes and components containing radioactive substances shall be specified in each individual case on the basis of the inventory of radioactivity.

3.4 Steel Reactor Containment

(1) The integrity of the reactor containment in the event of fire shall be ensured. Therefore, larger fire loads in the direct vicinity of the containment wall shall basically be avoided. Exceptions are such fire loads that are protected by suitable structure-related or equipment-related fire protection measures. In case such measures cannot be applied, other requirements shall be specified in each individual case, e.g., protective coating of the cables in the vicinity of cable penetrations.

(2) The measures specified under para. 1 shall also ensure that no fire spreading occurs on account the influence from direct heat or thermal radiation on the other side of the containment wall.

(3) The air locks and air lock annexes shall be kept free of any fire loads that are not required for the operation of the locks or for the purpose of personnel protection.

Note:
Requirements regarding the structural and other technical measures for air locks and air lock annexes are dealt with in safety standard KTA 2102 (in preparation). Requirements regarding the arrangement of the functional controls is specified in Sec. 15.2 KTA 3402 (Air locks through the containment vessel of nuclear power plants – Personnel locks) and in Sec. 14.2 KTA 3409 (Air locks through the containment vessel of nuclear power plants – Material locks).

(4) The function of safety-related actuators, valves and fittings shall be ensured such that even in the event of fire the necessary safety-related measures can be taken to the required extent.

Note:
This applies, e.g., to the inside main steam isolation valves and to the safety and relief valves of boiling water reactors (BWR), in order to ensure that an "intentional pressure relief" is possible even in the event of fire.

3.5 Reactor Coolant Pumps

(1) In the case of an external oil supply, the oil amount in the oil tank shall be monitored by suitable means. As soon as the oil amount falls below a minimum value to be specified depending on the oil supply, the oil supply shall automatically be interrupted.

(2) In the case of 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 an integrated oil supply with cooling equipment inside the oil vessel, the level in the oil vessel shall be monitored. When the maximum permissible level is reached, the cooling water supply to the oil cooler shall be shut off.

(4) Sec. 3.2.2.1 KTA 2101.1 shall be taken into consideration in the design of the oil supply lines of the reactor coolant pumps against external events. This shall basically also apply to the oil tank including the auxiliary equipment. In the case of an external oil tank, the oil tank including the auxiliary equipment in the same room does not need to be designed against external events, provided, it is validated analytically that the structural partitions of the fire sub-compartment of the oil tank compartment will remain functional even after an external event and that the oil collection vessel is still leak tight.

Note:
Requirements regarding the structural partitions of the fire sub-compartment of the oil tank are contained in safety standard KTA 2101.2.

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

3.6 Main Turbine (in nuclear power plants with BWR)

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

(2) A flame retardant control medium in fluid group HFD in accordance with VDMA 24317, or an equivalent fluid, shall normally be used for the turbine control system.

Note:
VGB-R 108 contains additional fire protection requirements.

3.7 Emergency Power Generating Facilities with Diesel-Generator Units

(1) The fuel oil storage tank of each redundancy shall be located, and the fuel oil day tank of each redundancy shall basically be located, in individual fire sub-compartments apart from the diesel generator units.

(2) The exhaust gas lines shall be insulated and encased with non-combustible building materials of Class A 1 in accordance with DIN 4102-1 such that the surface temperature even during continuous operation will not exceed 200 °C. It shall be ensured that neither fuel oil nor lubrication oil will penetrate into the insulation.

(3) The fuel oil system and the lubrication oil system of the diesel motor shall be routed or insulated such that no leakages can come in contact with components the surface temperatures of which are above 200 °C. The fuel oil injection lines shall be designed with a concentric guard pipe or with a comparable shielding.

(4) The pipe connections of fuel oil injection lines shall be metallically sealing or of an equivalent design.

(5) Fuel or oil leakages from the diesel motor, from the fuel oil day tank, fuel oil storage tank or supply lines shall be collected in, or drained into vats or vessels and shall be monitored and displayed. If applicable, a siphoning effect from the fuel oil tanks shall be taken into consideration.

3.8 Refrigeration Plants

(1) Non-combustible refrigerants shall normally be used.

(2) Insofar as combustible insulation materials are used, the fire protection measures specified under Section 3.12 shall be applied.

3.9 Storage of Combustible Operating Materials and Pressurized Gas Bottles

(1) It is not permissible to store combustible or combustion supporting gases, e.g., oxygen, in the vicinity of safety-related plant components. The storage of combustible or combustion supporting gases inside the controlled area shall be limited to the amounts required for the individual task.

(2) The storage of flammable liquids or other combustible or combustion supporting materials in the vicinity of safety-related plant components shall basically be avoided. This storage is only permissible if a fire of the materials stored cannot endanger any of the safety-related plant components. The exceptions are the diesel fuel required in accordance with KTA 3702 as well as the operating materials contained in the systems.

(3) It is not permissible to store flammable liquids in hazard classes A1, A2 and B in accordance with VbF together with other combustible or combustion supporting materials.

(4) In the case of storage of flammable liquids, means for the collection of the maximum possible non-isolatable amount of leakage from the largest individual vessel shall be provided for in the direct vicinity of the place of installation of this vessel; furthermore, means shall be provided to enable a controlled draining off of the accumulated fire suppressant and liquid leakage.

(5) No stationary pressurized gas bottles, even for non-flammable gases, may be installed in the vicinity of massive fire loads. Exempted are pressurized gas bottles for small fire extinguishing systems and for equipment protection systems.

3.10 Storage Facility for New Fuel Assemblies

(1) Neither 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 which the criticality analysis in accordance with Sec. 3.1.2.1 para. 3 KTA 3602 has confirmed that they will not cause criticality. The permissible fire suppressants shall be specified in the operating manual and listed at the entrance ways to the storage room.

3.11 Storage and Handling of Radioactive Combustible Wastes, Residual Substances and Used-up Equipment

Note:
Reference is made to VdS 2199 "Fire protection in the storage facility" and VdS 2218 "Guideline for the fire protection of storage facilities for dangerous materials".

(1) Such materials shall be collected in non-combustible and lockable containers. Flammable liquids 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.

(2) When storing such materials, an impermissible release of radioactive materials shall be prevented even under consideration of the fact that autoxidation can lead to combustible gases. Safety standard KTA 2103 shall be taken into account if the creation of combustible gases cannot be precluded.

3.12 Insulation, Encasements and Coatings of Components

(1) The insulation of pipes and components shall basically consist of non-combustible materials in building material class A in accordance with DIN 4102-1

(2) In the case of low-temperature insulations it is permissible to use combustible foam isolation materials or combustible auxiliary materials, provided,

a) the insulation material is in building material class B 1 in accordance with DIN 4102-1,

b) the insulation material after installation

   ba) is comparable to building materials in building material class B 1 in accordance with DIN 4102-1,

   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 possible leakages of flammable liquids, special measures shall be taken to prevent the penetration of these liquids into the insulation materials, e.g., by baffles or sheet metal encasements.

(4) The decontaminable coatings of components shall be at least flame retardant in accordance with building material class B 1 of DIN 4102-1 and, with regard to the development of heat and smoke, they shall correspond to materials in building material class A 2 in accordance with DIN 4102-1.

3.13 Exhaust-Gas Systems (Gas Treatment Systems)

Note:
Plant engineering measures and measure regarding surveillance and functional controls are dealt with in safety standard KTA 3605 "Treatment of radioactively contaminated gases in nuclear power plants with light water reactors". Reference is made to VdS 2154 "Inertisation of silos in the event of fire; Memorandum regarding damage prevention".

(1) With regard to exhaust-gas systems, measures shall be taken that will prevent the occurrence of a fire, that will ensure fire detection and will limit the extent of the fire.

Note:
In the case of boiling water reactors this is achieved at the state of art by providing, e.g.,

a) at least one pre-adsorber limited to the operationally required volume,

b) measurement equipment for carbon monoxide in the exhaust of the pre-adsorber the signals of which are displayed in the control room,

c) connections for the introduction of inertising gaseous fire suppressants and

d) individual isolating valves for the pre-adsorbers that can be isolated.

(2) The exhaust-gas systems in power plants with pressurized water reactors shall basically be operated under inert gas atmosphere.

(3) In the room of the place of installation, combustible materials are permissible only in such amounts as are required for the operation of the activated charcoal filters.

(4) The filter containers shall consist of non-combustible materials.

4 Fire Protection Measures for Electrical Facilities and Components

4.1 General Requirements

(1) A low risk of occurrence of fire and fire spreading in electrical facilities and components shall be achieved by the proper choice of materials and by corresponding protective means. To attain this goal the fire protection measures in accordance with the technical standards of VDE and DIN shall be supplemented by meeting the additional requirements as specified under this safety standard.

(2) The redundancies of electrical facilities and components shall be protected from each other, either by sufficiently fire resistant structural elements or the physical separation or encapsulation of combustible materials, such that a fire cannot cause the failure of an impermissible number of redundant equipment.

(3) The fire protection measures for electrical facilities and equipment specified in the following sections shall be applied with highest priority. Insofar as the measures specified under Sections 4.2 through 4.6 cannot be applied to the extent needed to ensure the required protection in the event of fire, additional measures regarding fire detection (e.g., by the installation of additional fire detectors) as well as regarding fire fighting (e.g., by installing stationary fire extinguishing systems) shall be specified.

4.2 Terminal Boxes

(1) Terminal boxes in areas with water extinguishing systems shall be protected as type IP 54 in accordance with DIN VDE 0470-1. Terminal boxes in the vicinity of fire loads shall normally meet the same requirement.

(2) Predetermined breaking points (designed weak points) on the terminal boxes of high-voltage motors shall be arranged such that escaping electric arc gases are guided onto the motor housing to which the boxes are mounted.

4.3 Transformers

It is not permissible to install transformers that contain liquid PCB. The use of transformers with any insulation liquids of class L in accordance with DIN EN 60 076-2 (VDE 0532 Part 102) shall, if required, be specified in each individual case.

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

(1) No cable ducts or large assemblies of cables other than required for the function of the switch gear itself are permissible in those regions which the manufacturer – with regard to electrical arc effects – has specified as the minimum distance between the switch gear and adjacent walls or plant components.

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

4.5 Cables and Cable Routing

(1) The instrumentation and electrical supply cables (in short, cables, in the following) of the fire protection equipment of one fire compartment or fire sub-section shall basically be designed or routed such that, in the event of a fire in this fire compartment or fire sub-section, the function of the corresponding fire protection equipment is ensured. The only exceptions permissible are in those cases where the function of the fire protection equipment has already been fulfilled at the point in time of cable destruction and later functioning of this equipment is not required.

Note:
Requirements regarding the functional capability of such cables are specified in DIN 4102-12.

(2) The use of cable fire shields in excess of 50 cm length and the use of coating materials requires certifying that the mechanical and electrical characteristics of the cables and their connections are maintained. Heat dissipation of the cables shall not be impermissibly impaired.

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

(4) In the case that, in accordance with Sec. 4.2.1 para. 4 KTA 2101.1, cables with an improved behavior in the event of fire are required, the cables shall be in accordance with DIN VDE 0250-214, DIN VDE 0266, DIN VDE 0282-9 and DIN VDE 0815/A1.

Note:
Additional details regarding "Halogen-free cables and special-application rubber cables with improved behavior in the event of fire" are contained in DIN VDE 0250-606 (in preparation).

(5) The cables (including cable mounting elements) used in systems that must be ensured to function in the event of fire shall be certified as being able to function for the required duration.

Note:
The functional performance of electric cables, especially for fire protection equipment, may be certified in accordance with DIN 4102-12.

(6) In the case of large assemblies of cables in those rooms of the controlled area which are designated for mobile fire fighting without heat and smoke removal systems, additional measures shall be taken with respect to the fire behavior of the cables.

Note:
Additional measures can comprise the use of coatings or of special cables.

4.6 Electric Heaters

(1) Mobile electric heaters shall be equipped with protective temperature limit switches in accordance with DIN EN 60730-1.

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

5 Fire Detection and Alarm Systems (including triggering of the close-and-retain systems of fire protection closures)

5.1 General Requirements

(1) The pertinent standards and regulations shall be applied; in particular, technical standards DIN VDE 0833-1 and -2 and standards series DIN EN 54 and DIN 14 675 shall be applied and VdS 2095 shall be taken into consideration. Supplementary and additional requirements are contained in the following sections.

(2) Insofar as fire detection and alarm systems must be designed against earthquakes, safety standard KTA 2201.4 shall be applied. It is permissible to alternatively assume that the fire detection and alarm facility stays available after an earthquake, provided, it is proven that the support structure of the fire alarm board retains its stability during earthquakes and it is ensured that any failed components in the fire alarm control center and in the corresponding local control centers

can, if required, be replaced (e.g., by exchanging the modules) or repaired at short notice.

5.2 Monitored Transmission Links (Primary Links), Detector Groups

Note:
The terms "primary link" and "detector group" are used in accordance with DIN VDE 0833-1.

(1) Fire detectors shall be connected to monitored transmission links (primary links). Several detector groups may be connected to a single monitored transmission link.

In the case that several detector groups are connected to a single monitored transmission link, it shall be ensured that a malfunction of the transmission link will not cause the failure of more than one detector group.

(2) It shall be prevented that a single malfunction can cause the failure of all detector groups in a fire compartment that are connected to an individual monitored transmission link.

(3) In the case of partitioned buildings (e.g., switch gear building, emergency feed building, emergency diesel building) and branch line facilities, only the detectors of the particular partition shall be connected to the individual transmission link. The detectors shall normally be correlated to only one redundancy.

(4) In the case of ring line systems, transmission links transgressing the different fire compartments are permissible, provided the following requirements are met:

a) Each ring shall be connected via two independent output lines to the fire alarm board.
b) Neither a malfunction nor an external event (e.g., fire) may cause a complete failure of the ring.
c) Each element connected to the ring shall automatically disconnect itself from the ring in the case of malfunction (e.g., by separator modules) without impairing the function of the other elements in this partition.
d) Any failures of the transmission links that could transgress the redundancies shall be prevented by proper arrangement and design.

(5) The detectors of a detector group shall normally be arranged to be in accordance with the arrangement of the redundant systems.

(6) In the case that a single fire compartment contains several ventilation areas that can be partitioned from each other by fire dampers and each ventilation area requires an individual control signal to activate the respective fire dampers in the ventilation ducts, then an individual detector group shall be available for each ventilation area.

(7) In the case that stationary fire extinguishing systems are automatically triggered from the fire detection and alarm system then the actuation of each fire suppression system in its fire extinguishing area requires a two-out-of-two dependency of the detector groups.

(8) The detectors belonging to one group shall normally be arranged such that they are all within, or all outside of, permanent exclusion areas in accordance with StrlSchV.

(9) Preventive measures shall be taken (e.g., radiation shielding) to ensure that the fire detectors in areas inaccessible during operation of the nuclear power plant will not become inoperative from operational effects (e.g., radiation) before the next major plant revision (refueling). It shall be possible to inactivate individual detectors from outside of the inaccessible areas. A malfunctioning detector shall not impair other detectors.

5.3 Fire Detectors and their Arrangement

(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,
f) stationary battery facilities, unless free of any fire load,
g) diesel units including the fuel oil depot,
h) large assemblies of cables (in particular, cable cellars, cable ducts or channels, cable wells conduit rooms, cable floors),
j) non-continuously manned control stations (this also comprises the control room area behind the control room panels and, furthermore, the local control stations, the remote shutdown station and the control room annexes),
k) storage for new fuel assemblies,
l) area for the storage and handling of combustible radioactive wastes in the radioactive waste storage facility,
m) other areas for the storage of combustible materials, e.g., oil depot,
n) decontamination room,
o) hot workshop,
p) oil-lubricated components with an oil reservoir or oil supply system, e.g., of the turbo-generator set (in BWR), of the main coolant pumps, of the feed water pumps, of the safety injection pumps, of the high-pressure charging pumps,
q) central air conditioning facility including, if applicable, filter compartments and air ducts of air-recirculation systems,
r) other important and fire endangered areas that are inaccessible during plant operation.

(2) The requirement for manual fire detectors in accordance with DIN EN 54-1 and, additionally, the automatic fire detectors shall be specified in each individual case.

5.4 Arrangement of the Fire Alarm Board, 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 control room annex.

(2) The display and control panel for detector groups associated with protective functions after external events shall, additionally, be installed in an appropriately protected area.

(3) In case the fire alarm board is installed in the control room annex but the display and control panels in the control room, then the transmission links between the two shall be monitored.

(4) If the display and control panels are installed in the control room annex, then the group alarm for fire and the one for a malfunction in the fire detection and alarm system shall be annunciated and optically displayed in the control room and – if the fire detection and alarm facilities have protective functions after external events – additionally in the emergency shutdown station. These alarms shall be designed as static and dynamic group alarms in accordance with DIN 19 235 such that every alarm coming from the fire alarm board and the last standing alarm are considered and that it can be seen that an alarm pertaining to a new operating condition is in the queue. A failure of a display and control panel shall be displayed in conjunction with the malfunction group alarm.

(5) In the case of a serial display of the fire alarms, the general display, namely, that further alarms are in the queue, shall be supplemented by a printout of the queued alarms to serve as a quick information for the head of fire actions.

(6) It is permissible to subdivide the fire alarm board into separate decentralized units, provided, the requirements in accordance with DIN VDE 0833-1 and DIN VDE 0833-2 and, additionally, the following requirements are met:

a) The individual subunits of the fire alarm control center shall continue self-sufficient operation even in the case of a malfunction of the transmission links to the other subunits.

b) Fire and malfunction alarms shall be displayed at the self-sufficiently operating subunit to the same extent as at the main display panel (e.g., display of the individual fire detectors and detector groups).

c) In case of a malfunction of the transmission links between the subunits, it shall be ensured that at least the fire and malfunction group alarms will be transmitted to the control room via an additional, monitored transmission link. The routing of individual transmission links shall be separated from the standpoint of fire protection.

d) The individual subunits of the fire alarm control center shall be arranged such that they are easily accessible.

(7) Data processing means with short access time shall be available for handling the fire alarms from the fire detectors. The incoming alarms shall be documented automatically. An action data file shall be available.

The tactical fire-fighting mission data shall also be available at all times to those subunits of the fire alarm board that are required to operated self-sufficiently in case of malfunctioning transmission links.

(8) In case the fire alarms require manual control procedures for the fire protection equipment, then the displays of the fire detection and alarm system, of the data processing means specified under para. 7 and of the actuating equipment of the controls shall be ergonomically coordinated such that a fast and unambiguous correlation to the affected regions, e.g., fire extinguishing areas, redundancy groups of the systems, is possible.

5.5 Design of the Fire Detection and Alarm Systems

The design of the fire detection and alarm system shall meet the requirements in accordance with Sec. 4.2.2 KTA 2101.1.

Malfunctions in, or impacts on, the fire alarm board and the control equipment, e.g., from electrical, magnetic, mechanical, or thermal influences, shall not lead to a simultaneous erroneous tripping of fire protection equipment in different redundancies unless it is certified that erroneous tripping is harmless from the standpoint of safety. Otherwise, the required fire alarm control centers and the control equipment shall be decentralized.

5.6 Close-and-Retain Systems or Fire Protection Closures

(1) Only those close-and-retain-systems shall be used that are approved under construction supervision legislation.

(2) The close-and-retain systems of those fire protection closures that must be kept open for safety-related reasons shall meet the following additional requirements:

a) The power supply of the close-and-retain systems shall be designed such that temporary voltage drops up to a duration of 1 second will not lead to triggering of the close-and-retain system.

b) Unless an uninterruptible emergency power supply is used, possible power interruptions (e.g., during bus switch-over or diesel start-up) shall be bridged for 30 seconds by a battery such that this interruption will not lead to triggering of the close-and-retain system. Other functions shall not be affected by this battery.

c) It is permissible to connect the close-and-retain system to the power supply of the fire alarm board, provided, the requirement of zero feed-back in accordance with Sec. 3.9.2 DIN VDEE 0833-1 is met. If applicable, the additional power requirements shall be taken into consideration in designing the battery and power supply.

d) If the fire detectors that, in accordance with Sec. 4.1 FeststellanlagenRL, must be installed on both sides of a fire protection closure and these detectors are themselves a part of the fire detection and alarm system, then they may belong to the same detector group.

e) The position “NOT OPEN” of the fire protection closures shall be signaled.

6 Fire Water System

6.1 General Requirements

(1) If individual fire water systems must be designed against external events in order to satisfy the requirements under Sec. 3.2.2.1 para. 2 and Sec. 4.2.4 para. 2 KTA 2101.1, then those components of the fire suppression water supply system that are necessary for the function of the fire water systems after the specific external event shall also be designed against this external event.

(2) Branch-offs to system parts that are not designed against external events shall be capable of being shut off by isolation valves that are designed against these external events.

(3) Insofar as the design against external events specified under para. 1 pertains specifically to earthquakes in accordance with KTA 2201.1, then the required parts of the system shall be designed in accordance with KTA 2201.4.

Note:
Requirements regarding the corresponding structural plant components are dealt with in KTA 2201.3 (in preparation).

(4) In order to protect against flooding it is permissible that isolation valves are installed in the fire water lines leading into the individual buildings; under normal conditions, these valves are in the closed position. It is permissible to manually operate these isolation valves from the control room whenever a fire alarm is given. Measures shall be taken to maintain water pressure in the blocked-off pipe line sections.

(5) Given a corresponding capacity for flooding, it is, alternatively, permissible that the inflow of fire water is limited by correspondingly qualified instrumentation and control equipment.

(6) The retention of fire water shall be dimensioned in accordance with the pertinent conventional guidelines and under consideration of the protection goal.

6.2 Fire Water Supply

(1) The fire water demand (100%) results from the largest stationary fire extinguishing system inside or outside of the buildings (sprinkler systems, spray water or foam extinguishing systems) plus a water demand of 1600 liters/min, e.g., for the open-air hydrants and the wall hydrants. The overall supply of available water shall amount to at least 3200 liters/min.

(2) In case the fire suppression water is supplied entirely from tanks or fire water pools, the following requirements apply:

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

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

c) If the water is stored entirely in 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 fails.

d) With specified normal operation of the fire water supply system, it shall be possible to refill the entire water supply (100%) within 8 hours.

(3) With regard to fire water removal by the fire brigade, a driveway for fire engines in accordance with DIN 14 090 shall be installed at a suitable location (e.g., water intake structure, cooling tower dish) and additionally, sufficient parking and maneuvering space as well as suction armatures for fire pumps shall be available. The supply inlet for the fire water ring line system in accordance with Sec. 4.2.3 KTA 2101.1 shall be at this location.

(4) In the condition ready for operation, the pipe system shall normally be filled with water that shall be harmless to the pipe system with respect to corrosion. Any suspended matter contained in the water shall not cause functional disturbances in the fire water supply.

(5) In the case of fire drills of the plant internal fire brigade that include tapping the fire water ring line system, a fire water flow rate of 600 liters/min shall be sustained for at least 15 min. During fire drills that include the fire water systems specified under para. 4, river water or waters of a similarly low quality shall be prevented from getting into the supply pipes and pipe networks of the fire water system.

(6) In the case that, during a fire fighting mission or for other reasons, waters of a lower quality have gotten into the fire water supplies including the stationary fire extinguishing systems, then the fire suppression system including all supply pipes, branchings, valves, fittings and nozzles shall be flushed and subsequently refilled with waters of a quality specified under para. 4.

(7) Fire water wells are permissible, provided, the wells are continuously in use – in order to prevent silting up of the well – not just for the supply of fire water but also for general operational water demands.

6.3 Hydrants

(1) Outside hydrants shall be installed 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, preferentially, be located close to the entrance ways of the building or close to other openings that are suitable to be used for fire fighting missions into the building. However, they shall be located away from regions endangered by falling-down structural components. The hydrants shall normally be located near the free movement areas for the fire brigade.

Note:
Details regarding the free movement areas for the fire brigade are contained in KTA 2101.2.

(2) Wall hydrants shall, preferentially, be located close to the stairways and shall normally be supplied by wet supply lines or wet rising mains. DIN 1988-6 applies to the dimensioning of the supply lines.

(3) In those areas where fires of liquids are possible, e.g., in the turbine or diesel areas, the wall hydrants shall, additionally, be equipped with foam extinguishing equipment.

6.4 Design of the Fire Water Lines

(1) The fire water ring line system shall be dimensioned such that the available flowing pressure is larger than or equal to 2 bar at the highest extraction point.

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

(3) The fire water lines shall be routed such that they are frost proof.

(4) The fire water lines shall be routed such that a leakage will not impair the function of more than one redundancy of safety-related equipment.

(5) In the case of underground-routed fire water lines, ductile cast-iron pipes shall normally be used that, under consideration of DIN 2614, are in accordance with DIN 28 610-1. A certification of suitability is required if other pipe materials are used.

7 Fire Suppression Equipment

7.1 General Requirements

(1) Stationary, automatically triggered fire extinguishing systems shall be installed for the oil-filled high-power transformers of the main off-site power connection and for the auxiliary station service branch-off in accordance with KTA 3701. This requirement also applies to the standby mains transformers if they are located in the direct vicinity of buildings.

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

(2) Stationary fire extinguishing systems shall normally be installed in rooms and on objects with, e.g., the following equipment:

a) turbine oil tanks and turbine oil channels,

b) fuel oil stored in the storage tanks and the fuel oil day tanks for diesel units,

c) main coolant pumps including oil tanks,

d) large unprotected assemblies of cables such as in cable ducts or channels, conduit rooms and cable floors,

e) unprotected cable transition points inside the reactor building,

f) waste treatment and storage of radioactive, combustible materials,

g) electronic data processing facilities.

(3) The need with respect stationary fire extinguishing systems having to meet special requirements in accordance with Sec. 4.2.4 para. 3 KTA 2101.1 shall be specified in each individual case.

(4) Depending on the individual application (cf. **Table 7.1-1**) the following fire extinguishing systems shall normally be employed:

a) water extinguishing systems,

b) gas extinguishing systems,

c) foam extinguishing systems.

Note:
Special conditions such as room geometry, environment, triggering behavior and danger from flooding, can lead to a different evaluation than shown in Table 7.1-1. It may be that, after assessment of an individual case, the application of other stationary fire extinguishing systems will be seen as more practical. Dry powder extinguishing systems in accordance with VdS Guideline 2111 are not dealt with in this safety standard because within its scope (cf. Section 1) they would be applicable only in very special cases, mainly because of the large effort required for a post-fire removal of the fire extinguishing agent.

(5) In the case of storage and handling of radioactive materials precautionary measures shall be taken to prevent distribution of radioactivity by the fire extinguishing agent.

In case of a fire in the controlled area, the entire fire water shall be retained inside the controlled area.

(6) If, in accordance with Sec. 3.2.2.1 KTA 2101.1, the function of fire extinguishing systems must be ensured even after an external event, then they shall be designed against the corresponding external event.

(7) Manual fire fighting measures may be used to replace possibly failed stationary fire extinguishing systems in those cases where fire fighting is required as being possible after the design-basis earthquake, provided,

a) it is ensured that an alarm is immediately issued (cf. Section 5.1) when a fire breaks out,
b) the supply of fire water is ensured (cf. Section 6.1)
c) the design-basis earthquake is considered in designing the stability of the required fire access routes.

Note:
Requirements regarding the design of the fire access routes against design-basis earthquakes are contained in KTA 2101.2.

Administrative arrangements (e.g., fire-fighting mission plans) shall be specified for these cases and shall be contained in the operating manual.

7.2 Water Extinguishing Systems

7.2.1 Spray Water Extinguishing Systems

(1) Spray water extinguishing systems shall be designed in accordance with DIN 14 494 under consideration of VdS 2109 and taking the deviating specifications under Sections 6, 7 and 10 regarding triggering, power supply, fire water supply and the tests and inspections into account. Spray water extinguishing systems with fine-spray nozzles shall be designed correspondingly.

(2) In the case of oil-conducting components and systems, each individual case shall be evaluated regarding the need for simultaneously triggering further fire extinguishing systems in the same fire sub-compartment; if a need exists, this shall be described in the fire protection concept.

7.2.2 Sprinkler Systems

Sprinkler systems shall be designed in accordance with DIN 14 489 under consideration of VdS 2092 and taking the deviating specifications under Sections 6, 7 and 10 regarding fire fighting water supply and the tests and inspections into account.

7.3 Gas Extinguishing Systems

Note:
In this context, also refer to KTA 2101.1 and to KTA 2102 (in preparation).

(1) Gas extinguishing systems shall be designed in accordance with the VdS Guidelines.

(2) Any damage to the pressure vessels including the associated valves and fittings of gas extinguishing systems shall have no adverse effects on safety-related plant components.

(3) Any impermissible pressure build-up and overly rapid reduction of the fire-gas concentration shall be prevented in the fire extinguishing area.

(4) When gas extinguishing systems are triggered in the controlled area, any cross-over gas flow, e.g., for pressure control, shall lead only into rooms of the controlled area.

7.4 Foam Extinguishing Systems

Foam extinguishing systems shall be designed in accordance with DIN 14 493 Parts 2 through 4 under consideration of VdS 2108 and taking the deviating specifications under Sections 6, 7 and 10 regarding triggering, power supply, fire fighting water supply and the tests and inspections into account.

7.5 Controls of the Fire Extinguishing Systems

7.5.1 General Requirements

(1) The energy supply systems for the controls shall be of a reliable design; in the case of electrical controls the power supply shall be ensured also upon failure of the normal power circuit.

(2) On-site manual triggering shall be independent of the auxiliary power for remote triggering and automatic triggering.

(3) Stationary fire extinguishing systems shall basically be triggered automatically. If an erroneous triggering could damage any equipment of the safety system or lead to a reduced power operation, then remotely triggered or on-site manually triggered fire extinguishing systems are permissible. In this case it shall be ensured that the possible fire effects can be kept under control up to the moment when these fire suppression systems become effective.

(4) The remote controls for fire extinguishing systems shall be installed in the control room.

(5) In the case of non-automatic triggering it shall be ensured that triggering occurs in good time and with high reliability. This requires that the triggering criteria as well as the instructions for manual triggering of the fire extinguishing systems are included in the operating manual. Triggering criteria shall be specified for each individual application.

Note:
Such criteria are, e.g., response of the fire detection and alarm system, visual surveillance with the closed-circuit television system of the plant as well as alarm signals indicating failure or malfunction.

(6) Manually triggered fire extinguishing systems shall be designed such that they will remain functional under the actual fire load density for the duration that it takes to perform manual triggering. Unless certified otherwise, a time of 15 minutes and a load density in accordance with the standard temperature curves (ETK) specified in DIN 4102-2 shall be taken as basis.

(7) The design and arrangement of the controls shall ensure that, in the event of fire in a particular fire-extinguishing area, the corresponding stationary fire extinguishing systems are triggered.

(8) Measures shall be taken to prevent erroneous triggering of fire extinguishing systems.

Note:
Such preventive measures are, e.g., combining two detector groups in the fire extinguishing area if automatic triggering is initiated by fire detectors, or applying the open-circuit principle to the controls.

(9) In the case of automatically triggered spray water extinguishing systems, it is permissible in well-founded cases to limit the spray induction time to a minimum of 5 minutes.

(10) Triggering of a fire extinguishing system shall be displayed in the control room.

(11) The requirements under paras. 2 through 6 do not apply to the sprinkler systems specified under Section 7.2.2.

7.5.2 Special Requirements for Gas Extinguishing Systems

(1) Gas extinguishing systems in the control room region shall be triggered exclusively by hand.

Note:
Personal safety has high priority in the area of the control room and control room annexes. It can be assumed that the continued presence of shift personnel ensures an immediate manual triggering of the gas extinguishing system.

(2) When triggering gas extinguishing systems, personal safety in accordance with the guidelines of the trade associations shall be ensured.

(3) Upon triggering a gas extinguishing system the room surrounding the corresponding fire extinguishing area shall be isolated. Unless other measures prevent an impermissible pressure build-up in the fire-extinguishing area, pressure relief devices shall be kept open during the gas induction procedure. These devices shall be closed shut after the end of gas induction in order to prevent an overly rapid reduction of the gas concentration.

7.6 Drainage for the Fire Water

(1) In rooms and areas protected by sprinkler systems or spray water extinguishing systems, the fire water shall either be collected or be drained off in a controlled and safe way.

(2) In the case of oil supply facilities with sprinkler systems or spray water extinguishing systems, the floor space of the oil supply facility shall be designed such that the water-oil mixture from the oil leakage and one single fire extinguishing procedure can either be collected or be directly drained off in a controlled and safe way; precautionary measures are required to ensure that the accumulated fire extinguishing agent and liquid leakage are drained off in a controlled way.

7.7 Mobile Fire Extinguishing Equipment

(1) Instead of portable fire extinguishers, it is permissible to also provide part of the fire extinguishing agent amount required in accordance with ZH 1/201 and ASR 13/1 in mobile equipment (no heavier than 50 kg).

(2) In the case of electrical equipment DIN VDE 0132 shall additionally be taken into consideration when applying the suitability table in accordance with ZH 1/201.

Note:
The possible damages caused by the fire extinguishing agent, e.g., in electrical and electronic equipment, shall be taken into account when choosing the fire suppressant.

8 Ventilation Systems, Heat and Smoke Removal Systems

8.1 Ventilation Systems with Functions in the Event of Fire

8.1.1 General Requirements

(1) Ventilation systems with functions in the event of fire comprise the following systems:

a) systems for removing the operational heat in areas not afflicted by the fire,
b) systems for maintaining a negative pressure with respect to the outer atmosphere,
c) systems for aerating the control room and emergency shut-down station,

Note:
The functions required of the systems under items a), b) and c) in the event of fire result from their technical scope during operation of the power plant.

d) heat and smoke removal systems,
e) systems for keeping the rescue routes free of smoke,
f) systems for removing the heat transferred from areas of neighboring redundancies in the event of fire.

(2) In the case of air-recirculation systems that supply more than one fire compartment or fire sub-compartment, the affected fire compartment or fire sub-compartment shall basically be isolated by closing appropriate fire dampers by remote control. If the fire dampers are not remotely controlled, a remote switchover to external air supply and air exhaust shall be possible.

(3) Those ventilation systems that, for safety related reasons, must retain their fire protection related functions even after external events, shall be designed against these events. Insofar as this involves earthquakes, the functional confirmation shall be performed in accordance with KTA 2201.4.

8.1.2 Heat and Smoke Removal

(1) The time required for the removal of smoke shall be specified in each individual case depending on the local conditions.

(2) The air volume flows required for the mechanical smoke removal shall be specified in each individual case.

Note:
Details regarding analytic methods are dealt with in DIN V 18 232-6 “Smoke and heat control installations - Powered smoke exhaust systems - Part 6: Requirements for components and suitability testing”.

(3) During the specified time required for the removal of smoke, the air volume flow shall not be interrupted, e.g., by closing fire dampers, constrictions in mufflers and clogging up of filters.

(4) The inlet air volume flow required for the removal of smoke shall be ensured. In the case of mechanical smoke removal, it is permissible that the required inlet air volume flow is also supplied from the inlet air to the air conditioning plant of the respective room; in this case, continued operation of the smoke removal system after a closing of the possibly installed inlet-air-oriented fire dampers is permissible, provided, the resulting pressure differences are not impermissibly high.

Note:
In this context, also refer to DIN V 18 232-6.

(5) In order to ensure the functional capability of the smoke removal, all components must be able to withstand the expected temperatures and pressures during the specified time for the removal of smoke. The cables including their mounting elements shall be designed as specified under Section 4.5 para. 5.

(6) Heat and smoke removal systems designed to serve several stories or fire compartments shall normally have special smoke removal conduits in addition to the air exhaust ducts.

(7) Only sufficiently flame resistant smoke exhaust dampers shall be used in order to prevent the spreading of fire through the smoke removal conduits into regions unaffected by the fire.

(8) The actuating equipment for opening the smoke exhaust dampers shall ensure that they will open reliably in the event of fire. Unfavorable effects from the circumambient flow around the flap shall be taken into consideration.

(9) Ventilators used for heat and smoke removal shall be designed for the temperatures to be expected. The design shall basically consider a temperature of 600 °C. A lower design temperature is permissible, provided, it is proven that lower smoke temperatures can be expected due to, e.g., a cooling-off along the smoke removal conduits, a lower temperature of the fire, or the admixture of air. The temperature design of the ventilators shall be proven by a test certificate or expert report.

Running No.	Fire Extinguishing Area		Water Extinguishing Systems			Gas Extinguishing Systems		Foam Extinguishing Systems	
			Spray Water Systems		Sprinkler Systems	Room Protection	Equipment Protection	Heavy Foam	Light and Medium Foam
			normal nozzles	fine nozzles					
1	Large assemblies of cables: partitioned off in cable ducts or channels, cable wells and cable rooms		+	+	o [1]	o [2]	/	–	o [3]
2	Large assemblies of cables and cable transition points: not partitioned off		+	o [15]	o [4]	–	/	–	–
3	Rooms with electronic data processing and electronics		–	o [14]	o [1] [16]	o [2]	o [14]	–	–
	Associated conduit rooms		o [13]	+	o [13]	o [2]	/	–	–
4	Switch gear, switch gear buildings	≤ 1000 V	–	o [14]	o [1] [5] [16]	o [2]	o [14]	–	–
		≥ 1000 V	–	–	o [1] [5] [16]	o [2]	o [14]	–	–
5	Transformers		+	o [7]	o [8]	o [2] [7]	o [2] [7]	o [8]	–
6	False-floor hollows	accessible	o [13]	+	+	o [2]	/	–	–
		not accessible	o [13]	+	o [5]	+	/	–	–
7	Fuel-oil containing components and system	partitioned off	+	+	+	+	+	+	+
		not partitioned off	+	o [15]	+	–	o [9]	o [8]	–
8	Storage rooms for combustible materials		o [10] [12]	o [10] [12]	o [10] [12]	o [2] [12]	o [9]	o [11] [12]	o [3] [11] [12]

\+ suitable
o partly suitable
— not suitable
/ not applicable

1) Slow triggering behavior; additional measures against smoke dissipation might be required.
2) Problem with personal safety; no cooling effect; pressure buildup from fire extinguishing agent to be taken into consideration.
3) Foam generator shall not draw in smoke; possibility given for corresponding air displacement.
4) Sprinkler is suited as fire protection of equipment, provided, the remaining fire loads are individually protected by a fire extinguishing system.
5) Only as a controlled deluge valve facility.
6) Only for transformers in small, closed-off rooms.
7) Only for transformers in closed-off rooms.
8) Foam must be applied with sufficient adhesion to be effective with regard to fire extinguishing.
9) Only suitable as fire protection of individual equipment if an inverse ignition can be precluded for all component parts.
10) Not suitable for flammable liquids of hazard class A 1 and A 2 in accordance with VbF nor for combustible gases.
11) The expected fire intensity and local conditions shall not cause a premature destruction of the foam.
12) Cf. Section 7.1 para. 5
13) Depending on the height.
14) As protection for the cabinets.
15) Depending on the room geometry and air flow.
16) As protection of the buildings.

Table 7.1-1: Suitability of stationary fire extinguishing systems in fire-extinguishing areas typical of nuclear power plants

8.1.3 Dilution or Removal of Smoke along Rescue Routes

8.1.3.1 General Requirements

(1) Smoke dilution or smoke removal along rescue routes (protected corridors and necessary stairways) shall be achieved by providing

a) equipment for a natural venting or

b) mechanical airing and venting facilities for purging with air.

(2) Natural venting shall basically not be applied in stairways below ground level. Exceptions are permissible in the case that only insignificant amounts of smoke are expected from lower floor levels connected to the stairways..

(3) If a natural venting of rescue routes is not possible (e.g., in the cases of radiologically relevant regions in the controlled area, of protected corridors without a sufficient number of openings to the outside, or of closed doors due to plant security), a ventilation system shall be used to dilute the smoke penetrating into the rescue routes by purging with air.

8.1.3.2 Natural Venting

(1) Natural venting shall be achieved using smoke removal equipment approved according to the building code of the individual State (Land).

Note:
The effectivity of the natural venting of stairways is reduced by restrictions that apply with respect to the opening of exit doors or other air inlet-air openings above ground level (e.g., on account of plant security).

(2) Whenever the thermal smoke removal of stairways are opened up, this shall be displayed and documented in the control room.

8.1.3.3 Mechanical Airing and Venting Facilities for Purging with Air

(1) Regarding the mechanical airing and venting facilities outside of the containment interior, the ventilation system for purging with air shall be designed such that a sufficient dilution of the smoke is achieved for the assumed duration of the escape procedure. The dilution factor shall be specified in each individual case. The assumed duration of the escape procedure shall be specified in the fire protection concept.

Note:

a) An escape procedure is generally assumed to take up to 15 minutes.

b) The requirements with respect to the air volume flow rate of the mechanical airing and venting facilities to be used for the dilution of smoke by purging can be reduced by considering the arrangement of annexes and air locks that lie between the fire room and the rescue route.

(2) The air flow shall be guided such that it purges the rescue routes along their entire lengths and is supported as far as possible by thermal updraft.

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

(4) It is recommended that the pressure difference in the vicinity of doorways does not exceed p = 50 Pa in order to avoid that the force required for opening the doors becomes too large.

8.1.3.4 Stairways and Air Lock Annexes inside the Containment of a PWR

(1) In the event of fire inside the containment of a PWR, as much as possible of the entire normal-operation inlet air flow shall normally be branched off for the airing of stairways and air lock annexes.

Note:
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 in each individual case.

(2) During major revisions when there is a significant increase in the number of persons inside the containment, the air supply to the stairways and air lock annexes shall be increased in the event of fire. The requirements shall be specified in each individual case.

(3) The necessary controls with regard to paras. 1 and 2 shall be performed remotely from the control room.

8.2 Controls, Displays, Power Supplies

8.2.1 Controls for Fire Dampers, Smoke Dampers and Smoke Exhaust Dampers

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

(2) The independent triggering specified under para. 1 shall normally be performed automatically by smoke detectors or at least from well accessible local control stations. In the case of difficult accessibility, a remote triggering shall normally be possible from the control room. It shall be checked in each individual case whether or not the automatic triggering by smoke detectors can be applied.

(3) The smoke dampers in ventilation systems with air recirculation shall be triggered by devices that react to smoke and are built into the air recirculation ducts.

Note:
The suitability of the automatic triggering devices is tested in accordance with the "Construction and testing principles for shut-off devices against smoke in ventilation ducts" issued by the German Institute for Civil Engineering (DIBt).

(4) In the case that air conditioning and ventilation systems are also employed for heat and smoke removal, it shall be ensured that the required fire dampers and smoke exhaust dampers are properly controlled even under the room temperatures expected upon required operation (cf. Section 8.1.2).

(5) Additional triggering devices and motorized actuators may be employed for different tasks, provided, they are completely separated from the thermal triggers and the related closing devices.

(6) In order to prevent an unwanted closing of the air inlet flap caused by reversed currents, the controls for the smoke exhaust damper shall be designed such that this damper opens up automatically when a fire damper in the air exhaust duct closes.

Note:
It is necessary that the smoke exhaust damper is automatically opened in order to prevent an unwanted closing of the air inlet flap caused by a reversed flow of hot smoke.

8.2.2 Controls of Heat and Smoke Removal Systems

(1) The controls for the smoke removal for stairways shall be installed near the exit to the outside and, additionally, at least at the top floor. In case of an automatic triggering of the smoke removal for stairways, one control station at the exit level is sufficient.

(2) In the case that air conditioning and ventilation systems are also employed for the heat and smoke removal, the switch-over from mixed or recirculated air operation to inlet and exhaust air operation shall be triggered automatically by smoke detectors.

(3) Early smoke detection and the design and arrangement of the switching and control equipment shall be such that proper functioning of the heat and smoke removal systems is ensured upon required operation. This applies, especially, to components catching fire in the same room where the switching and control equipment is installed.

(4) Thermal smoke removal shall, in addition to the triggering devices in accordance with DIN 18 232-2 (soft-solder trigger on the exhaust flap itself), be provided with on-site devices for their manual triggering.

8.2.3 Position Indicators, Alarms

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

a) Each fire damper shall individually signal its status "NOT OPEN" to the corresponding local control station. Each local control station shall send a corresponding group alarm to the control room.

b) Each fire damper shall individually signal its status to the control room area if this feedback is necessary for further control actions from the control room area such as "Smoke Removal ON" or if the fire damper is located in an area where the creation of combustible gases is possible.

c) Each fire dampers in explosion endangered areas shall signal its individual status "NOT OPEN" to the control room area if ventilating actions are required with regard to explosion protection.

(2) In addition to the fire damper position signals, the following information shall be displayed at least at the respective local control station:

a) the operation of those ventilation systems with functions in the event of fire,

b) the closing of the fire protection doors (fire protection closure) which during normal operation are in the open position for reasons of ventilation.

A corresponding group alarm shall be displayed in the control room.

(3) Each smoke exhaust damper shall signal its status "OPEN" to the corresponding local control station.

8.2.4 Routing of Cables for Controls and Signaling and for Other Controls-Oriented Transmission Devices

(1) Cables required for controls and feedback signaling shall basically meet the requirements specified under Section 4.5.

(2) It is permissible, in deviation of para. 1, to route the controls and feedback signaling cables of fire dampers directly through the room to be protected, provided, it is ensured that the fire dampers are immediately triggered when the fire alarm is issued.

(3) Cables required for controls and feedback signaling of heat and smoke removal equipment shall be routed such that the equipment maintains its required functionality in the event of fire.

(4) In the case of fire dampers in accordance with KTA 2101.1 Sec. 4.3.2 para. 2, the open-circuit principle shall be applied to the design of the controls in order to prevent erroneous triggering.

8.2.5 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 triggering. In the case of stairways, these ventilators shall be triggered either remotely from the control room or automatically by smoke detectors.

The local control stations shall be located at the access points to the secured corridors and, in the case of stairways, at least at the top and bottom levels as well as at the exit level. In case of an automatic triggering of the ventilators, one control station at the exit level is sufficient.

(2) Ventilators used for the heat and smoke removal shall be equipped with on-site controls for their manual triggering. These ventilators shall be, additionally, triggered either remotely from the control room or automatically by smoke detectors. It shall be ensured that during the 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.

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

8.2.6 Power Supply

(1) A reliable power supply shall be provided for the ventilation systems as specified under Section 8. The auxiliary power supply in accordance with Sec. 2 para. 1 KTA 3701 may be considered as sufficiently reliable.

(2) The ventilation systems specified under Section 8.1.1 para. 3 shall, additionally, be connected to the emergency power supply.

(3) All controls and displays of the ventilation systems specified under Section 8.1 shall be connected to the emergency power supply.

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

8.3 Design of Special Systems or Components

8.3.1 Stationary Activated Charcoal Filters and High-efficiency Particulate Air Filters

Note:
Requirements regarding mobile filter systems are specified in each individual case.

(1) Filter shells shall consist of non-combustible materials (cf. Sec. 4.2.1 para. 2 KTA 2101.1)

(2) Tightly closing ventilation flaps shall be arranged before and after filter units with activated charcoal. The ventilation flaps shall be triggered from the control room. Smoke detectors shall be installed in the duct on the inlet air side of the first ventilation flap. 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 the activated charcoal filters and high-efficiency particulate air filters shall be bypassed.

(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 after the filters and before the ventilation flaps. The alarms shall be displayed in the control room.

Note:
In non-flow-through filter system the natural buildup of the carbon monoxide concentration can lead to false alarms.

(5) In the room where activated charcoal filters and high-efficiency particulate air filters are installed, combustible materials are permissible only in such amounts as are required for the operation of these filters and of the ventilation systems.

8.3.2 Accident Filtration Systems

Note:
Accident filtration Systems are the exhaust air filtration facilities in accordance with KTA 3601.

(1) Accident filtration systems shall not be used for the removal of smoke. The requirements specified under Section 8.3.1 paras. 2 through 4 do not apply to accident filtration facilities.

(2) The penetrations of air ducts of the accident filtration system through structural partitioning elements that have fire protection functions shall be designed in accordance with KTA 2101.1 Sec. 4.3.1 para. 7. The design shall also be such that a transmittal of smoke is prevented.

Note:
This may be achieved for the penetration itself by designing it as a steel pipe penetration in accordance with DIN 4102-11.

9 Location of Alarms, Displays and Control Elements Relevant to Fire Protection

Note:
Alarms of the fire detection and alarm system are dealt with in Section 5, the alarms, displays and control elements of the fire extinguishing systems in Section 7.5.

(1) The remote controls and the displays of the feedback signals from the fire dampers and from the close-and-retain systems for doors specified under Section 5.6 shall be located in a control room annex or in local control stations. Position indicators shall be provided in the control room for those fire

protection doors that must be kept open, among others, for reason of pressure equalization (e.g., inside the containment).

(2) The display and control elements specified under para. 1 shall be arranged and marked such that the ergonomic requirements under Section 5.4 para. 8 are met

(3) Displays and alarms from procedure engineering systems and components that are indicators of the function of these systems and components that, at the same time, have fire protection aspects (e.g., monitors of the bearing temperature of pumps or motors) shall be arranged – from the view point of process engineering – together with the other monitoring displays of these systems and components.

(4) Regarding fire protection equipment that have protective functions after external events, the remote controls, the displays of feedback and malfunction signals shall, to the required – maybe even additional – extent, be located in correspondingly protected areas.

10 Tests and Inspections

The tests and inspections shall be performed in accordance with Sec. 7 KTA 2101.1.

Appendix

Regulations Referred to in this Safety Standard

Regulations referred to in this safety standard are only valid in the version 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.

StrlSchV		Ordinance on the protection from damage by ionizing radiation (Radiological Protection Ordinance - StrlSchV) of October 13, 1976, (BGBl. I p. 2905, 1977 p. 184, 296), in the version published on June 30, 1989 (BGBl. I, 1989, p. 1321), corrected October 16, 1989 (BGBl. I, 1989, p. 1926) most recently changed by ordinance of August 18, 1997 (BGBl. I, p. 2113)
VbF		Ordinance on facilities for on-the-ground storage, filling and transport of flammable liquids (Flammable Liquids Ordinance – VbF) of February 27, 1980 (BGBl. I p. 173, 229) in the version published December 13, 1996 (BGBl. I p. 1937, corrected 1997 p. 447)
KTA 2101.1	(12/00)	Fire protection in nuclear power plants; Part 1: Basic requirements
KTA 2103	(06/00)	Explosion protection in nuclear power plants with light water reactors (General and case-specific requirements)
KTA 2201.1	(06/90)	Design of nuclear power plants against seismic events; Part 1: Principles
KTA 2201.4	(06/90)	Design of nuclear power plants against seismic events; Part 4: Requirements for the procedures for verifying the safety of mechanical and electrical components against earthquakes (amended by BAnz. No. 115 of June 25, 1996)
KTA 3602	(06/90)	Storage and Handling of nuclear fuel assemblies, control rods and neutron sources in nuclear power plants with light water reactors
KTA 3701	(06/99)	General requirements for the electrical power supply in nuclear power plants
KTA 3702	(06/00)	Emergency power generating facilities with diesel-generator units in nuclear power plants
DIN 1988-6	(12/88)	Codes of practice for drinking water installations (TRWI) - Part 6: Fire fighting and fire protection installations; DVGW code of practice
DIN 2614	(02/90)	Cement mortar linings for ductile iron and steel pipes and fittings; application, requirements and testing
DIN 4102-1	(05/98)	Fire behaviour of building materials and building components – Part 1: Building materials; Concepts, requirements and tests
DIN 4102-1	(08/98)	Amendment of DIN 4102-1:1998-05 – Amendment 1
DIN 4102-2	(09/77)	Fire behaviour of building materials and building components; Building components; definitions, requirements and tests
DIN 14 090	(06/77)	Areas for the fire brigade on premises
DIN 14 489	(05/85)	Sprinkler extinguishing systems; general fundamentals

DIN 14 493-2	(07/77)	Fixed foam extinguishing systems; low expansion foam systems
DIN 14 493-3	(07/77)	Fixed foam extinguishing systems; medium expansion foam systems
DIN 14 493-4	(07/77)	Fixed fire extinguishing foam systems; high expansion foam systems
DIN 14 494	(03/79)	Water spray systems, fixed, with open nozzles
DIN 14 675	(01/84)	Fire alarm systems; Erection
DIN 18 232-2	(11/89)	Structural fire protection in industrial buildings; Smoke and heat control installations; Design, construction, performance and installation of smoke vents
DIN 19 235	(03/85)	Measurement and control; signalling of operating conditions
DIN EN 545	(01/95)	Ductile iron pipes, fittings, accessories and their joints for water pipelines - Requirements and test methods; German version EN 545:1994
Normenreihe DIN EN 54		Fire detection and fire alarm systems Part 1 (10/96); Parts 2 and 4 (12/97); Part 3 (E 02/96); Parts 5 through 8 (09/89); Part 9 (08/84); Parts 10 and 11 (E 09/91); Part 12 (E 03/92); Parts 13 and 14 (E 11/96)
DIN EN 60 076-2 (VDE 0532 Teil 2)	(12/97)	Power transformers - Part 2: Temperature rise (IEC 60076-2:1993, modified); German version EN 60076-2:1997
DIN EN 60 730-1 (VDE 0631 Teil 1)	(01/96)	Automatic electrical controls for household and similar use - Part 1: General requirements (IEC 60730-1:1993, modified); German version EN 60730-1:1995 + A11:1995
DIN VDE 0132	(11/89)	Measures to be taken in the case of fire in or near electrical installations
DIN VDE 0250-214	(02/87)	Cables, wires and flexible cords for power installation; Halogen-free light sheathed cable with improved fire behaviour
DIN VDE 0266	(11/97)	Power cables with improved characteristics in the case of fire – Nominal voltages U_0/U 0,6/1 kV
DIN VDE 0282-9	(03/96)	Rubber insulated cables of rated voltages up to and including 450/750 V - Part 9: Single core non-sheathed cables for fixed wiring having low emission of smoke and corrosive gases in the event of fire; German version HD 22.9 S2:1995
DIN VDE 0470-1	(11/92)	Degrees of protection provided by enclosures (IP code) [IEC 60529:1989]; German version EN 60529:1991
DIN VDE 0815/A1	(05/88)	Wiring cables for telecommunication and data processing systems; Amendment 1
DIN VDE 0833-1	(01/89)	Alarm systems for fire, intrusion and hold-up; General requirements
DIN VDE 0833-2	(07/92)	Alarm systems for fire, intrusion and hold-up; Requirements for fire detection and alarm systems
VdS 2092	(06/87)	Rules for sprinkler systems: Planning and installation including VdS 2092-S (08/98)
VdS 2095	(08/93)	Guidelines for automatic fire alarm systems; Planning and installation including VdS 2095-S (06/95)
VdS 2108	(02/85)	Guidelines for foam extinguishing systems; Planning and installation
VdS 2109	(08/90)	Guidelines for fire suppression spray-water systems; Planning and installation including VdS 2209-S (02/96)
ASR 13/1, 2	(06/97)	Fire extinguishing equipment (BArbBl, 1997, No. 7/8, p. 70-73)
FeststellanlagenRL	(10/88)	Guidelines for close-and-retain systems (German Institute for Civil Engineering (DIBt), Berlin – formerly IfBt)
ZH 1/201	(1996)	Rules for the equipment of work places with fire extinguishers
VDMA 24317	(08/82)	Fluid technology; Hydraulics; Flame retardant hydraulic fluids; Guidelines