From: David Diec
To: James Downs; Ray Gallucci
Date: Tue, Mar 23, 2004 7:19 AM
Subject: Re: Comparision between Fire Protection Regulations between Germany and USA

glad to hear. I wouldn't want to think that we are the first to face a running away train. Apparently, we are.

David Diec, Project Manager
U.S. Nuclear Regulatory Commission
Phone: 301-415-2834
Fax: 301-415-1032
Email: dtd@nrc.gov

>>> Ray Gallucci 03/22/04 05:04PM >>>
I think the wording and intent of Sections 6.7 inhibit, if not preclude, extrapolating to include OpManAx. I believe, as James, that any manual actions refer only to fire brigade/manual suppression activities.

>>> David Diec 03/22/04 04:51PM >>>
Take a look at Section 6.7.3, Fire Prevention (pg 10). One could argue that "measure required in case of a non-availability of structural fire protection measures" to include manual actions. However, I cannot find measure required for systems and components fire protection measures.

David Diec, Project Manager
U.S. Nuclear Regulatory Commission
Phone: 301-415-2834
Fax: 301-415-1032
Email: dtd@nrc.gov

>>> James Downs 03/22/04 04:31PM >>>
I believe that reference in made to fire brigade operations... but here's KTA 1201 to be sure.

>>> David Diec 03/22/2004 4:26:49 PM >>>
The German code mentioned Section 6.7 of KTA 1201 code discusses substitute measures in situation where measured and equipment-related protections are not available, as well as **the behavior of personnel in case of fire.** Do we have access to this document (KTA 1201)?

David Diec, Project Manager
U.S. Nuclear Regulatory Commission
Phone: 301-415-2834
Fax: 301-415-1032
Email: dtd@nrc.gov

>>> James Downs 03/22/04 03:25PM >>>
I already sent these to Alex and Sunil, but if you want to read the actual code for yourself, its attached.

>>> Ray Gallucci 03/22/2004 3:21:22 PM >>>
"Few equivalencies are given in the German code to permit deviation from the mandated structural separation requirements **and no references of any manual actions are cited as alternative means of fire protection."**

How interesting.

>>> James Downs 03/22/04 01:33PM >>>
Attached is the paper, it compares the German KTA 2101 series to the NRC fire protection regulation.

22-6

-JD

>>> Sunil Weerakkody 03/22/2004 1:12:34 PM >>>
This is an outstaning product because it is written at the right level of detail with no editorial errors. I was able to read the document and understand the high-level diffrences beween us and German regulations within about 10 minutes. Please share this with the rest of the section. Please send me an e-copy because I want to share this with Suzie, Mike and John.

Sunil

CC: Eva Brown; Phil Qualls

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 2101.1 (12/2000)

Fire Protection in Nuclear Power Plants
Part 1: Basic Requirements

(Brandschutz in Kernkraftwerken
Teil 1: Grundsätze des Brandschutzes)

The previous version of this safety standard was issued 12/85

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 1: Basic Requirements**	KTA 2101.1

The previous version of this safety standard, December 1985 was issued in BAnz No. 33a on February 18, 1986

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 +49-221-94373603).

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 equipment-related 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 basic requirements regarding these precautionary measures are specified in this safety standard.

(3) To achieve the protection goals, the following aspects that can influences the occurrence, spreading and effects of a fire are, among others, taken into consideration:

a) fire loads and ignition sources,

b) structure-related and equipment-related features,

c) possibilities for fire alarms and fire fighting.

Corresponding technical and organizational measures are specified. The extent and quality of the measures and the extent of the tests and inspections are determined in accordance with the significance of fire protection in respect to the protection goals specified under Section 1.

(4) 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 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 exemptions shall be handled on a case-by-case basis in accordance with the procedures specified in these individual regulations.

(5) The safety standard series KTA 2101 also comprises the following parts:

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

KTA 2101.3 Fire protection in nuclear power plants Part 3: Fire protection of mechanical and electrical plant components

(6) Certain requirements regarding fire protection are also specified in the following safety standards:

KTA 1201 Requirements for the Operating Manual

KTA 2102 Rescue routes in nuclear power plants (in preparation)

KTA 2103 Explosion protection in nuclear power plants with light water reactors (general and case-specific requirements)

KTA 2501 Waterproofing of structures of nuclear power plants

KTA 3301 Residual heat removal systems of light water reactors

KTA 3403 Cable penetrations through the reactor containment vessel

KTA 3501 Reactor protection system and monitoring of the equipment of the safety system

KTA 3601 Ventilation and air filtration systems in nuclear power plants

KTA 3602 Storage and handling of nuclear fuel assemblies, control rods and neutron sources in nuclear power plants with light water reactors

KTA 3604 Storage, handling and on-site transportation of radioactive substances (other than fuel assemblies) in nuclear power plants

KTA 3701 General requirements for the electrical power supply in nuclear power plants

KTA 3702 Emergency power generating facilities with diesel generator units in nuclear power plants

KTA 3904 Control room, emergency control room and local control stations in nuclear power plants

(7) Requirements regarding quality assurance and regarding alarm facilities and lightning protection facilities are specified in the following safety standards:

KTA 1401 General requirements regarding quality assurance

KTA 1404 Documentation during the construction and operation of nuclear power plants

KTA 2206 Design of nuclear power plants against damaging effects from lightning

KTA 3901 Communication devices for nuclear power plants

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 materials and
   ad) limitation of radiation exposure,
b) the structural plant components which enclose these plant components and
c) the plant personnel.

Note:
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 KTA 2101.2 and KTA 2101.3.

(1) Postulated Event

A postulated event is an event on which the safety related design of a nuclear power plant is based and which can set off an entire event sequence.

(2) Structural and Equipment-related Fire Protection

Structural and equipment-related fire protection includes structure-related and equipment-related fire protection measures that prevent the occurrence and spreading of fires and that make it possible for persons to escape and be rescued and that, also, make effective fire extinguishing activities possible.

a) Structure-related fire protection measures include measures that result from requirements regarding the fire behavior of structural materials and elements (e.g., walls, ceilings and isolating components), the location of fire compartments and arrangement of fire barriers, the location, arrangement and design of rescue routes as well as the on-site access roads and areas for the fire brigade.

b) Equipment-related fire protection measures include equipment and devices for the detection and fighting of fires (fire protection equipment and devices), insofar as these are permanently attached to the buildings, e.g., fire extinguishing devices, fire detection and alarm systems, heat and smoke removal systems. Equipment-related fire protection measures also include measures taken with the goal of preventing fires in mechanical and electrical plant components. These are, e.g., measures resulting from the fire behavior of components and systems including their operating media.

(3) Operational Fire Protection

Operational fire protection includes administrative measures (e.g. plant-internal fire brigade as well as instructions on the handling of combustible operating and working media) as well as mobile equipment for fire fighting (e.g., fire extinguishers) and for the escape and rescue of people(e.g., breathing apparatus).

Note:
Operational fire protection measures are described in the plant-internal Fire Protection Regulation.

(4) Fire Compartments

A fire compartment is the region of the building within its outer walls and/or inside walls which are designed as fire walls extending through all stories.

Note:
Requirements for the design of fire walls are specified in KTA 2101.2.

(5) Fire Sub-compartments

Fire sub-compartments are subsections of fire compartments that, on account of an increased fire hazard or for the protection of equipment of the safety system are partitioned off by sufficiently fire resistant structural elements such that fire spreading to, and having impermissible effects on, other subsections is prevented.

Note:
Regarding the design requirements, see KTA 2101.2.

(6) Fire Load

The fire load in the combustion energy (mass × specific combustion heat) of the combustible materials contained in , and belonging to, the room.

(7) Fire Load Density

Fire load density is the ratio of fire load to area of the room or of the group of rooms.

(8) Fire Damper

Fire dampers are active isolating devices against fire and smoke that are triggered by the fire variables "heat" or "heat and smoke".

(9) Rescue Route

A rescue route is a route that leads from any place in the room if required via necessary corridors, protected corridors and necessary stairways into the open or into a protected area; it serves both as escape route and, from the outside, as rescue route.

(10) Functional Capability

Functional capability is the ability of a system or of one of its component parts (e.g., component, subsystem, train) including the necessary auxiliary, supply and power systems to perform the prescribed tasks.

(11) Authorized Expert

Authorized expert is an expert person or organization consulted in accordance with Sec. 20 Atomic Energy Act by the licensing or supervisory authority.

(12) Safety System

The safety system comprises all equipment of a nuclear facility that have the task of protecting the facility from an impermissible loading and, when a design basis accident (incident) occurs, to keep the effects on the plant personnel, on the facility and the environment within specified limits.

Note:
Although equipment-related fire protection measures can be relevant to safety, they are not part of the safety system.

(13) Ignition Sources

Ignition sources are the permanently or temporarily available possibilities in an area of the plant which could release the amount of ignition energy required to ignite the available combustible material.

(14) Random Failure

The random failure is a failure which occurs statistically independently of failures of other similar equipment.

(15) Encapsulation

Encapsulation is a measure that is suitable to protect individual equipment or combustible materials such that, in the case of fire within or outside of the encapsulation, they will not become part of the fire scenario.

(16) Protected Area

A protected area is an area that is protected against the dangerous events that are at the root of the escape or of the rescue mission.

3 Design Principles

3.1 Basic Requirements

3.1.1 General

(1) Measures for the protection from fires and the subsequent effects shall be taken in nuclear power plants. These measures shall ensure that the protection goals specified under Section 1 are achieved.

(2) A minimization of fire loads shall be taken into account in specifying, both, the fire protection measures and the fire protection concept. Measures that are in correspondence with the chosen fire protection concept as specified under Section 3.1.2.1 shall be taken for the fire protective separation or encapsulation of combustible materials, for minimizing the smoke development as well as for preventing anticipated ignitions sources in the areas of open combustible materials.

(3) Its shall, basically, be assumed that the ignition of combustible materials is possible. An exception may be made in the case of the events specified in Section 3.2.2, provided, plausibility considerations prove that the combustible materials cannot be ignited as a result of these events. An exception may also be made if the combustible material is encapsulated

and it is proven that the encapsulation retain their functional capability during specified normal operation and during the postulated design basis accidents (incidents) – including fire.

Note:
This assumption, that combustible materials will ignite, serves to find the maximum fire effect for determining the required fire resistance rating of the fire enclosures of fire compartments and fire sub-compartments. It does not serve as boundary condition of fire-sequence related incident analyses.

(4) Fires do not have to be assumed to occur in inerted areas, e.g., the inerted BWR containment vessel. The situation during the non-inerted phases shall be taken into account.

(5) Structure-related fire protection measures of the structural and equipment-related fire protection, e.g. the creation of fire compartments, fire sub-compartments and areas separated by structures that are at least fire resistant, shall be given priority over equipment-related fire protection measures. Insofar as the above-mentioned structural measures cannot be implemented to the extent that the necessary protection is ensured in the case of fire, additional measures regarding the detection of fires (e.g. installation of additional fire detectors) as well as the fighting of fires (e.g. installation of stationary fire extinguishing systems) shall be taken.

(6) If safety-related reasons call for additional requirements regarding structural and equipment-related fire protection measures, e.g., radiation protection requirements, then their fire protection function shall be evaluated taking these additional requirements into account.

(7) Structural and equipment-related fire protection measures shall be designed such that a fire-related failure need not be assumed in case of their required operation.

In the case of fire in combination with other events in accordance with Section 3.2, the extent to which the structural and equipment-related fire protection measures may be damaged as a result of these events shall be examined, and it shall be determined whether further measures are necessary.

(8) Equipment of the safety system necessary for

a) shutting down the reactor,

b) maintaining long-term subcriticality,

c) removing residual heat,

d) retaining radioactive substances (adherence to the planning limits in accordance with Sec. 28 para. 3 StrlSchV)

shall be protected such that they can carry out their safety-related tasks to the required extent even in the event of fire. In the case of redundant equipment of the safety system, it shall basically be ensured that, in case of a fire in the area of one redundancy, the other redundancies will retain their functional capability. A failure of several redundancies as well as the failure of non-redundant equipment of the safety system in the event of a fire is permissible, provided, the simultaneous occurrence of a fire and the necessary safety-related operation of the respective equipment of the safety system does not have to be assumed.

Note:
Whether or not it is required that the nuclear power plant is shut down after a fire-related failure of equipment of the safety system is not subject of this safety standard.

(9) The fire protection design of anchors and supports of components shall be in accordance with the corresponding requirements of the components.

(10) The entirety of fire protection measures shall ensure that, in the case of a fire, a random failure of a single measure of the structure-related fire protection is not relevant to safety.

Note:
The basic measures required in this respect are specified in this safety standard and are dealt with in detail in safety standards KTA 2101.2 and KTA 2101.3. Accordingly, it is not required in the fire protection design to assume a random failure (single failure) of an individual fire protection measure.

Insofar as individual fire protection measures have special significance with regard to protecting the equipment of the safety system, their reliability shall be ensured by special measures that shall be specified on a case-by-case basis.

Note:
The special significance of individual fire protection measures and the resulting reliability requirements may be determined on the basis of probabilistic safety analyses. Special measures are, e.g., expanded test requirements, stationary fire extinguishing systems instead of manual fire fighting or automatic instead of manual triggering of the fire extinguishing systems.

(11) With regard to a fire in combination with other events as specified under Section 3.2, it is not required to assume the random failure of an individual fire protection measure.

3.1.2 Fire Protection Concept

3.1.2.1 General

A fire protection concept shall be developed and documented under consideration of the rules and regulations mentioned in Section Fundamentals (e.g., VBG 30, MBO, ArbStättV) as well as the requirements specified under Section 3.1.1. The fire protection concept shall be developed for full power operation including the maintenance tasks. Deviations on account of a shutdown reactor as well the starting up and shutting down time phases shall be taken into consideration.

All measures directed at achieving the protection goal shall be described in the fire protection concept.

3.1.2.2 Further Particulars on the Fire Protection Concept

The nuclear power plant specific demands on fire protection shall be incorporated in the fire protection concept. This includes the safety related evaluation of the plant components affected by the fire as well as of the fire protection requirements specified in the following sections, e.g., with regard to a reliable physical separation of redundancies and the design against earthquakes.

In the case of plant regions where Sections 3.2 requires that fire shall be analyzed in conjunction with a postulated other event, then the additional requirements or additional influences from this postulated event shall be specified.

Note:
The signal cables of the instrumentation and control system may be neglected when determining the potential ignition sources.

3.1.2.3 Investigation of Fire Effects

(1) If the safety related evaluation of the plant components affected by fire make it necessary to perform a detailed analysis of the fire effects, then corresponding data shall be given with respect to these fire effects.

This data may be derived from suitable analytical or experimental proofs, or may be proven with the help of analogy or plausibility considerations.

Note:
Refer to Sec. 3 KTA 2101.2.

(2) The following fire effects shall be considered:

a) heat development inside of the fire room or area,

b) heat development outside of the fire room or area,

c) development and spreading of smoke,

d) pressure buildup inside of the fire room or area.

(3) The analysis of fire effects shall take, e.g., the following parameters into account:

a) fire loads (taking encapsulations into consideration) and ignition sources,

b) spatial geometry and type of component, heat sinks and heat sources,

c) ventilation conditions,

d) possibilities for fire alarms and fighting the fire under consideration of the chronological sequence of the fire.

3.2 Fire and Postulated Events

3.2.1 Fire and Subsequent Event

(1) In the case of pressurized vessels and components as well as of plant components where an inherent failure can be excluded on account of the individual quality characteristics, or of the limitation of the type of failure, measures shall be taken either to prevent fires in the area of pressurized vessels or components or to protect against the effects of fires; it may, alternatively, be demonstrated that in the event of fire the quality characteristics making it possible to exclude an [inherent] failure or to limit the type of failure are not adversely affected in an impermissible way.

Note:
Such pressurized vessels and components are, in the case of pressurized water reactors, e.g., reactor pressure vessel, steam generators, pressurizers, primary coolant pumps and accumulators, and in the case of nuclear power plants with boiling water reactors the scram accumulator tanks.

Corresponding plant components are, e.g., containment vessel, safety-related supports and associated structural plant components as well as the storage pool for used fuel assemblies.

With regard to the mentioned quality characteristics, this can pertain to, e.g., stress limit usage. A limitation of the type of failure is given, e.g., in case of a basic safety design in accordance with RSK-Guidelines for Pressurized Water Reactors.

(2) In the case of pressurized vessels and components as well as of plant components where an inherent failure cannot be excluded, measures shall be taken either to prevent fires or to protect these pressurized vessels and components as well as the plant components against the effects of fire. Alternatively, measures may be taken to protect the equipment of the safety system against the simultaneous impact of a fire and of a consequential event resulting from the above-mentioned vessels, components and plant components on account of the fire.

3.2.2 Postulated Event and Consequential Fire

3.2.2.1 Earthquakes and Consequential Fire

(1) Inside structural plant components which, because of their safety-related significance, are designed against earthquakes in accordance with KTA 2201.1, either the equipment which, on losing integrity, would release combustible materials or the equipment which could cause ignition shall basically also be designed to resist the effects of these events by selecting suitable materials and by an appropriate design.

Note:
By implementing this requirement, a consequential fire due to earthquakes need not be assumed.

The individual building parts shall be specified in the fire protection concept.

(2) If the equipment mentioned in para. 1 has not been correspondingly designed, then structural and equipment-related fire protection measures shall be provided which shall themselves be designed to resist the effects of these events by the selection of suitable materials and mechanical design. In this case, the consequential fire shall be considered to occur only after the earthquake has subsided.

Note:
The individual fire protection measures shall be specified in the fire protection concept.

(3) Insofar as the intensity, , of the presumed earthquake is presumed to be less than or equal to 6 (on the MSK scale), it may be assumed that the structure-related and operational fire protection measures will remain available even without special design measures.

3.2.2.2 Plant-internal Events and Consequential Fire

(1) The structure-related fire protection measures shall be carried out such that in the case of redundant equipment of the safety system any fire assumed to be a direct consequence of a plant-internal event will, basically, remain restricted to a single redundancy of this equipment. The failure of several redundancies as well as the failure of non-redundant equipment of the safety system is permissible in substantiated exceptional cases, provided, the simultaneous occurrence of a fire and the required safety-related operation of the respective equipment of the safety system does not have to be assumed.

(2) In this context, the occurrence of a fire does not have to be assumed for design basis accidents (incidents) involving the release of steam.

3.2.3 Postulated Event and an Unrelated Fire

Note:
This section does not in any way affect the requirements specified under Section 3.2.2.1.

(1) The simultaneous occurrence of an external event (earthquake or high water) or of an internal event and an unrelated fire, basically, does not have to be assumed because the occurrence probabilities of such combinations are sufficiently small. However, if the combination of the hundred-yearly high water with a fire and restricted access conditions of the plant has a safety-related significance, then this combination shall be postulated.

(2) An unrelated fire shall, basically, not be excluded after an earthquake or high water. In this case, however, only those structure-related or operational fire protection measures need to be available or be made available which are necessary to for retaining the functional capability of the equipment specified under Section 3.1.1 para. 8.

Note:
In his case it is permissible to also fall back on help external to the nuclear power pant site.

The following shall apply to this equipment:

a) With respect to minor earthquakes up to the inspection level in accordance with KTA 2201.6, the availability of the structure-related fire protection measures shall, basically, be maintained by engineering means (e.g., by adhering to the pipe routing provisions approved in the licensing procedure).

b) Insofar as the intensity, , of the above-mentioned earthquakes are presumed to be smaller than or equal to 6 (on the MSK scale), it may be assumed that the structure-related and operational fire protection measures will remain available even without special design measures.

c) The structure-related and operational fire protection measures need not be designed against larger earthquakes up to the design-basis earthquake, provided, it is ensured that after the occurrence of a design-basis earthquake the possibly failed structure-related or operational fire protection measures can be made available or be replaced by suitable measures immediately after the event.

Note:
"Immediately after the event" refers to a maximum time period of one week.

Regardless of these requirements, in case of post-earthquake tasks with special fire hazards (e.g. heat intensive tasks) additional administrative fire protection measures (e.g. mobile fire pumps, fire guard) shall be provided.

3.3 Reactor in the Shutdown Condition

(1) The structure-related and operational fire protection measures shall be reviewed with regard to whether or not they shall be modified or supplemented in view of the modified operating conditions during this plant condition (shutdown reactor, possible additional combustible materials or a change of their location, possible ignition sources during repair work, additional personnel during inspection, servicing and repair work).

(2) The additional fire loads usually present during the revision phase shall be taken into consideration in selecting the structure-related fire protection measures.

(3) The fire protection concept shall reflect the changed conditions regarding fire protection, shall describe the basic measures and shall indicate that additional measures may become necessary and that these measures, then, shall be specified in each individual case.

Note:
These measures include, in particular, operational fire protection measures such as fire guard, the availability of additional fire extinguishers and restrictions on bringing in additional fire loads. In this regard, also refer to Section 4.2.5.4.

4 Structural and Equipment-related Fire Protection Measures Against Building-Internal Fires

4.1 Structure-related Fire Protection Measures

4.1.1 Fire Load

(1) The fire load shall be kept as small as possible.

(2) Non-combustible construction materials in accordance with Class A DIN 4102-1 shall basically be used. If combustible materials are used it shall be demonstrated that suitable non-combustible materials are not available.

(3) Combustible construction materials shall, basically, be flame retardant in accordance with Class B 1 DIN 4102-1. With regard to smoke development, they shall, basically, comply with the requirements in accordance with Class A 2 DIN 4102-1. They shall be taken into consideration in determining the fire loads.

Note:
Specifications regarding the requirements for the fire behavior of decontaminable coatings and cold-water insulations are dealt with in Sec. 7.3 para. 3 KTA 2101.2 and Sec. 3.12 KTA 2101.3.

(4) Fixed flooring and decontaminable coatings may be ignored as fire load, provided, it is proven that they would contribute only negligible amounts to the fire scenario on account of their type, amount and condition of installation. Fire protection coatings (e.g. intumescent coatings) may be ignored as fire load, provided, it proven that, under consideration of the fire exposure from unprotected fire loads, they would contribute nothing or only negligible amounts to the fire scenario.

4.1.2 Encapsulation

(1) Encapsulations are permissible. These can be in the form of sheet metal jackets, fire protection plates or intumescent coatings.

(2) It shall be shown that the individual technical encapsulation measures are suitable with regard to the objective of the fire protection concept. This shall take into consideration the type of combustible material to be protected, the installation, amount and distribution of the unprotected and other fire loads as well as the operating conditions to be observed and, in this connection, the general restrictions to be taken into consideration.

4.1.3 Fire Protective Separation

Note:
Further details regarding fire protective separation are contained in KTA 2101.2.
The formal requirements to be taken into consideration when deviating from regulations under public law are described in Section Fundamentals para. 4.

(1) The individual structures in a nuclear power plant shall be separated from one another either by sufficient distances or by sufficiently fire resistant structural elements.

(2) The structural components shall basically be subdivided into fire compartments taking the requirements imposed by systems engineering into consideration.

(3) The individual fire compartments shall be subdivided basically into single-story fire sub-compartments under consideration of the fire load densities, the requirements with regard to system engineering and operation as well as the redundancies and rescue routes.

In case systems engineering requires a configuration of multi-story fire sub-compartments, then additional fire protection measures shall be taken in order to achieve an equivalent protection condition.

(4) The walls, ceilings and isolating components of fire sub-compartments shall have a sufficient resistance to fire.

(5) If the requirements of systems engineering lead to the requirement that the fire compartments must be larger than in accordance with the building code or that the fire protection requirements of individual structural elements cannot be completely met, then other suitable measures (e.g., creation of fire sub-compartments, encapsulation of fire loads, object-related fire alarms, stationary fire extinguishing systems) shall be taken if these measures help to achieve the protective goals.

Note:
Examples of this are: reactor building, reactor auxiliary building, turbine building, reactor service building.

(6) Insofar as pressure equalization openings are necessary for the control of design basis accidents (incidents), openings in structural partitions are permissible, provided, they comply with fire protection requirements.

In this case, it is permissible that the openings are closed automatically only in case of fire or that the closures are opened only in case of pressure equalization. The corresponding protection measures shall be specified in each individual case.

(7) In the case of necessary openings in outer walls, it shall be ensured that the spread of fire from one fire compartment to another is prevented. The corresponding protection measures shall be specified in each individual case.

(8) Ventilation ducts and pipes which pass through the partitions between fire compartments or fire sub-compartments shall be designed such that a fire cannot spread from one area to another. The fire resistance rating of the special elements employed for this purpose shall comply with the fire protection requirements for the partitioning structural elements.

(9) Penetrations for cables and pipes through fire walls or through separating walls or ceilings of other fire sub-sections shall be provided with fire barriers. The fire resistance capability of these fire barriers shall be equal to that of the partitioning structural elements.

After working on the fire barriers of cables and pipes, it shall be ensured that these fire barriers either remain in functioning order or are again returned to this state.

(10) In the case of ventilated pipe and cable ducts that are sectionalized for fire protection purposes, the ventilation openings shall be provided with fire dampers or fire protection isolating components. Their fire resistance capability shall correspond to that of the partitioning structural elements.

(11) Redundant equipment of the safety system shall be protected either by sufficiently fire resistant structural elements (at least F 90-A in accordance with DIN 4102-2) or by physical separation such that a failure of several redundancies as a result of a fire can be excluded under the boundary conditions mentioned in Section 3.1.1 para. 8. In well founded exceptional cases this same protection goal may be achieved by encapsulation (ensuring continuation of functionality) or by cable systems with ensured continuation of functionality or by fire extinguishing systems or by combination of these measures.

(12) Insofar as physicals separation is the only suitable fire protection measure in accordance with Section 3.1.1 to ensure necessary functional capability of the equipment of the safety system in case of fire, then

a) the stability of the ceilings and walls used for this purpose as well as
b) the functional capability of the fire protection isolating components and fire barriers required in each individual case

shall be demonstrated under consideration of the requirements resulting from the analyses in accordance with Sections 3.2.1, 3.2.2 and 3.2.3.

Note:
It shall be assumed that the fire protection closures and fire barriers are in specified normal condition at the point in time of the aforementioned loading.

(13) In the case of substantial fire loads, e.g., large assembly of cables in cable rooms, fuel storage compartments for the emergency power diesels, separate sufficiently fire resistant areas (at least F 90-A in accordance with DIN 4102-2) shall normally be provided.

4.1.4 Areas and Fire Access Routes for the Fire Brigade

It shall be ensured that, with regard to the preparation for an intervention by the fire brigade, the required free movement areas for the fire engines, for the positioning of equipment and for the preparation of rescue and fire fighting operations including the necessary fire access routes and fire entries are available. DIN 14 090 shall basically be applied in this connection.

Note:
Exceptions are dealt with in Sec. 4 KTA 2101.2.

Fire access routes for the fire brigade and rescue routes shall be kept clear of obstructions.

Note:
In particular, the rescue routes provided in accordance with KTA 2102 are considered as fire access routes for the fire brigade.

4.2 Equipment-related Fire Protection Measures

4.2.1 Fire Load

(1) Basically, only non-combustible operating media shall normally be used. Exceptions are permissible for hydraulic and lubrication fluids as well as for other combustible materials, provided, they are unavoidable for operational reasons. It is recommended to use flame retardant hydraulic fluids.

Note:
Corresponding details are specified in safety standard KTA 2101.3.

(2) Basically, only non-combustible materials shall be used. However, the use of combustible materials is permissible, provided, they are unavoidable from a design standpoint, e.g., insulating materials around cold piping, decontaminable coatings. The combustible materials shall basically correspond to Class B 1 DIN 4102-1. The use of combustible materials required from a design standpoint is permissible without certification, provided, only a negligible increase of the fire hazard is incurred, e.g., internal coatings, underground-routed cables outside of buildings, seals and small parts.

Note:
Under comparable conditions, materials can be classified as combustible and non-combustible in accordance with DIN 4102-1.

(3) Negligible fire loads (e.g., flange gaskets, identification tags, coatings of mechanical components) may be ignored. The determined fire loads may be ignored in the fire protection design, provided,

a) they are stored inside the components in a condition where an ignition can – even under an external fire influence – be precluded, or
b) the components – depending on the external or internal ignition possibilities – are designed against possible loadings during specified normal operation and retain their functional capability during the postulated design basis accidents (including fire), or
c) it is proven that under consideration of effects of the fire the combustible materials will not be set free.

(4) In the containment vessel of light water reactors, only such cables shall basically be used that counteract rapid fire spreading and that do not release corrosive gases in the case of fire (e.g., special halogen-free cables).

Note:
Requirements for such cables are specified in safety standard KTA 2101.3.

Exceptions are permissible where special electrical properties (e.g. measuring cables) or special mechanical properties (e.g. flexibility) are required. In case of an amassing of cables inside the containment vessel that do not have the above mentioned characteristics, then the protection goal shall be achieved by other suitable means.

4.2.2 Fire Alarm

(1) A fire detection and alarm system with automatic fire detectors shall be provided. The extent and arrangement of the automatic fire detectors depend on the following aspects:

a) fire load density,
b) arrangement of the combustible materials in the rooms,
c) burning behavior (spreading of flames, smoke development) of the combustible materials,
d) safety relevance of the components or systems,
e) personnel protection (ensuring escape and rescue),
f) criteria for triggering fire dampers, fire protection isolating components,
g) criteria for triggering stationary fire extinguishing systems.

Note:
Corresponding details are specified in safety standard KTA 2101.3.

(2) The fire detection and alarm system shall normally be designed to ensure a sufficiently exact location of a fire including the identification at the fire alarm boards.

Note:
Details are specified in safety standard KTA 2101.3.

(3) Interference levels due to, e.g., soiling of the automatic fire detectors shall normally be automatically compensated for.

(4) Erroneous alarms shall not trigger impermissible control signals. This pertains, in particular, to earthquakes and plant-internal design basis accidents (incidents).

(5) It shall be possible, depending on the fire protection concept, to control the fire protection equipment from the fire alarm boards.

(6) Insofar as fire fighting measures are necessary in the case of fire to ensure the required functional capability of equipment of the safety system, it shall be demonstrated that the fire detection and alarm system retains its functional capability even under consideration of the requirements resulting from the analyses in accordance with Sections 3.2.1, 3.2.2 and 3.2.3.

(7) The displays and controls necessary for the head of fire actions shall be installed in the control room or in a control room annex. At least one group alarm of the fire detection and alarm system shall be installed in plain view of the control room personnel.

(8) Overview plans indicating the alarm zones, the access routes and the locations of fire fighting equipment as well as instructions regarding proper behavior in the case of fire alarms and of malfunctions of the fire detection and alarm systems shall be provided in the direct vicinity of the control room.

Note:
Computer printouts are permitted, provided a documentation is available in the direct vicinity of the control room.

4.2.3 Fire Water Supply

(1) A sufficiently large fire water system shall be provided.

Note:
Corresponding details are specified in safety standard KTA 2101.3.

Either a natural source of water such as rivers, streams, lakes, or an artificial source of water such as a fire water pond in accordance with DIN 14 210, a fire water well in accordance with DIN 14 220, or a fire water tank in accordance with DIN 14 230 with a sufficient quantity of water shall be available as fire water supply. The water may be fed into the fire water system by means of fire pumps or high-level storage tanks.

(2) A fire water ring line system shall be installed on the site in the vicinity of the buildings and shall be kept permanently under pressure. It shall be possible to subdivide the ring line system such that, even in case of a break at any point, basically all structural plant components specified in Section 1 can be supplied with sufficient amounts of fire water; the exceptions are the cooling-water intake and outfall structures.

(3) The underfloor hydrants in accordance with DIN 3221 and the pillar hydrants in accordance with DIN 3221 shall also be connected to the fire water ring line system. Hydrants shall be located near the entrances to buildings and, outside on the site, in close vicinity of the buildings.

Note:
The hydrants may, alternatively, be supplied from a dedicated separate system, provided, its design is equivalent to that of the ring line system.

(4) All buildings accommodating equipment of the safety system shall basically be provided with wet rising mains. It shall be ensured that, in the case of loss of integrity of such mains, the functional capability of the equipment of the safety system is retained to the extent that they can still fulfill their specified functions in the case of design basis accidents (incidents). Wall hydrants in accordance with DIN 14 46-1, DIN 14 461-6, DIN EN 671-1 and DIN EN 671-2 shall be located such that all possible fire sources can be reached by the fire water jet.

(5) The fire pumps shall be redundant and shall be equipped with a protected or independent power supply; a pressurizer system shall be provided. Fire pumps or high-level storage tanks shall be spatially separated or protected such that an event causing the failure of an individual fire pump, high-level storage tank or supply line to the ring line system does not lead to a failure of supplying the required amount of water in case of required operation.

(6) The fire pumps or high-level storage tanks shall be switched on line automatically if there is a pressure drop in the fire water system. In addition, it shall be possible to monitor and operate them from the control room. It shall normally be only possible to switch off the pumps by manual action.

(7) It shall be possible to reopen the containment vessel penetration valves of the fire water supply after their closure was triggered by the reactor protection system.

4.2.4 Fire Extinguishing Systems

(1) Stationary fire extinguishing systems shall be provided for in the case of large unprotected fire loads either from easily combustible operating media or that are seen in a combination with, e.g.,

a) difficult access (e.g., cable duct, rooms with a high local dose rate) or

b) rapid fire propagation or

c) inadequate smoke or heat removal.

(2) Fire extinguishing systems shall be designed such that, in case of malfunctions and operating errors upon required operation, the functional capability of the safety system is retained to the extent that it can perform its specified normal function in the case of design basis accidents (incidents). If, in case of fire, the necessary functional capability of the equipment of the safety system is ensured exclusively by means of fire extinguishing systems, then the functional capability of these fire extinguishing systems shall be demonstrated under consideration of the conditions resulting from the analyses specified under Sections 3.2.1, 3.2.2 and 3.2.3. In selecting the fire extinguishing agent, care shall be taken to ensure that the equipment of the safety system to be protected is not rendered inoperable as a result of the effects cause by the fire extinguishing agent.

(3) Insofar as stationary fire extinguishing systems are provided as exclusive fire protection of the equipment of the safety system, their reliability shall be ensured in accordance with Section 3.1.1 by means of special measures to be specified in each individual case.

(4) Stationary fire extinguishing systems shall basically be activated automatically. Remotely controlled or on-site manually actuated fire extinguishing systems are permissible, provided, the possible fire effects up to the moment when these fire extinguishing systems become effective can be kept under control.

Note:
In the assessment of an automatic activation due consideration shall be given to the disadvantages of an erroneous activation, e.g., the failure of safety-related equipment, an erroneous activation in the case of steam leakage, contamination of the fire water and the effects of the fire extinguishing agent on the parts with high surface temperatures.

(5) If cables with an improved behavior in case of fire are used, e.g., special halogen-free cables or cables and cable

ducts with a fire protection coating (e.g. intumescent coatings), then it shall be demonstrated in the individual case whether stationary fire extinguishing systems are necessary or not.

Note:
Also refer to Section 4.2.1 para. 4.

(6) Insofar as large quantities of water must be expected during the fire extinguishing procedure, e.g. in the case of spray water suppression systems, possibilities for removing the water, if necessary by means of mobile pumps, shall be available.

Fire water from the controlled area shall basically only be discharged under controlled conditions. Exceptions are permissible in the case of temporarily installed controlled areas, provided, the release of radioactive substances is not to be expected.

(7) In the case of remotely controlled fire extinguishing systems, the electrical triggering devices shall be installed either in the control room or in a control room annex.

4.2.5 Heat and Smoke Removal

4.2.5.1 General Requirements

(1) The ventilation systems may be used in case of a fire for the mechanical smoke removal. When used for this purpose, the requirements to be specified for the temperature and pressure resistance of individual structural elements of the ventilation systems may be specified under consideration of the mixture temperature attained in the ventilation pipes.

(2) If ventilation systems are planned to be used for heat and smoke removal, they shall be arranged such that smoke is not carried into the air supply.

(3) If mechanical heat and smoke removal equipment is used, it shall be ensured that this does not endanger persons nor any equipment of the safety system in other areas separated by fire protection measures from the area affected by the fire.

(4) The measures to be taken in the individual case shall be specified depending on the local conditions. Specific aspects are:

a) location of the room,
b) the possibilities for air supply and air exhaust with the ventilation system,
c) objective of the smoke removal, e.g., ensuring mobile fire fighting activities,
d) restrictions regarding radiation protection, e.g., small air supply and exhaust volume.

4.2.5.2 Heat and Smoke Removal from Structural Plant Components Outside the Controlled Area

Heat and smoke removal systems shall be provided for those structural plant components specified in Section 1 that are outside the controlled area unless it is ensured through other fire protection measures that the heat and smoke removal is not required for fire fighting. The available ventilation systems may be used for this purpose if they are appropriately designed and constructed.

4.2.5.3 Heat and Smoke Removal from Structural Plant Components Inside the Controlled Area

(1) Smoke removal from the structural plant components of the controlled area is allowed to the extent required for fire fighting and to rescue people. This shall basically carried out only via the paths designated for the discharge of radioactive substances during specified normal operation.

Note:
Depending on its location and duration, a fire can lead to circumstances which must be classified either as abnormal operation or as a design basis accident (incident). A large-volume smoke removal is not possible from the interior of the reactor building because of the requirements regarding control and mitigation of a loss-of coolant accident.

Nuclide-specific measurements are not necessary since the environmental radiological exposure can be determined to sufficient accuracy by other ways after the smoke has been removed.

(2) The heat and smoke removal via paths other than the discharge paths for specified normal operation (e.g. via built-in dampers for the heat and smoke removal to the outside) is permitted from those sub-areas of the controlled area which are separated in terms of fire protection and ventilation and which have been demonstrated to be radiologically irrelevant (e.g. necessary stairways); it is also permitted from the turbine building (BWR).

(3) If the ventilation system is provided with air filtration units, it shall be ensured that, e.g, temperature, pressure, fire products or fire extinguishing agents do not have impermissibly adverse effects on the air filtration units.

Note:
For example, under consideration of the expected environmental radiological exposure, provisions can be made to bypass the filter unit.

(4) It shall be ensured that the removal of cold smoke after a fire will be possible. This smoke may also be removed via the existing ventilation system. Prior to the discharge of cold smoke, a sample shall be taken and analyzed with respect to its content of radioactive substances

4.2.5.4 Keeping Rescue Routes Free of Smoke

(1) In the case of plant-internal fires, protected corridors and necessary stairways shall be kept free of smoke to such extent that there is enough air for breathing and adequate visibility for orientation.

Note:
Inside the reactor building interior, it may become necessary that the ventilation of the rescue routes must be switched off for reasons of radiological protection and that as a result the rescue routes will not be entirely clear of smoke.

(2) Necessary stairways may be kept clear of smoke by natural convection or by mechanical equipment. Mechanical equipment shall be provided for the protected corridors. Outside of the rescue routes specified under para. 1, the air supply lines to these rescue routes shall basically be of a fire resistant design. The air supply lines should have the same fire resistance rating as those building elements enclosing the protected rescue routes. Air exhaust lines shall normally have the same fire rating as the corresponding air supply lines.

Regarding the reactor building interior, equipment-related special features shall be taken into consideration.

Note:
Details regarding fire rating are specified in safety standard KTA 2101.2.

The installation of air supply and exhaust openings for natural convection may be complicated by other requirements, e.g. regarding radiological protection or plant security.

In general, natural convection is only effective in stairway sections above ground level.

(3) Technical measures shall normally be provided with regard to airlock annexes in the reactor building interior and the stairways connected to these annexes such that, under conditions prevailing during major inspections (e.g. unlocked and open airlock doors of personnel airlocks), a sufficient ventilation of these annexes and stairways is achieved for the duration required for the escape from the containment vessel.

Restrictions arising from radiological protection considerations shall be taken into consideration. In the case of a fire, the entire air supply shall normally be fed directly into the above-mentioned annexes and stairways.

4.2.6 Displays and Controls of Other Equipment Relevant to Fire Protection

The remote controls and the check-back and malfunction displays of other equipment relevant to fire protection, e.g., position detectors of the fire dampers, shall be installed in the control room or in a control room annex. At least one group alarm of the fire alarm system shall be installed in the control room or control room annex and to the required extent in the remote shutdown station. At least one optical and acoustical collective alarm shall be located in the control room.

Note:
Details regarding displays and controls of the other equipment are specified in Sec. 9 KTA 2101.3.

4.3 Fire Protection Measures for Ventilation Systems and Exhaust-Gas Systems

4.3.1 General Requirements for Ventilation Systems

(1) The ventilation systems shall be designed such that they shall basically be designed to be in conformity with the building supervision guidelines.

Exceptions are permitted as specified under Section Fundamentals para. 4 for the following reasons:

a) radiation protection (e.g., maintaining subatmospheric pressures during design basis accidents (incidents)),
b) physical separation of redundancies with the goal of being able to operate the unaffected redundancy,
c) prevention of the spreading of smoke,
d) possibilities for the removal of smoke,
e) keeping the protected corridors and necessary stairways free from smoke.

(2) In the event of fire, a spreading of smoke and radioactivity into unaffected areas shall be prevented as long as possible.

Note:
This may be achieved, e.g., by avoiding air circulation operation or by proper control of the fire dampers.

(3) In the case of redundant equipment of the safety system where the redundancies are separated from each other by structure-related fire protection measures, the associated ventilation systems shall be arranged, designed and constructed such that a fire of one redundancy does not affect the functionality of other redundancies.

(4) The ventilation of the control room and the emergency control center and their annexes shall be ensured even in the case of a fire in directly adjacent fire compartments. This does not apply to a fire in the ventilation system itself.

(5) It is recommended that the ventilation equipment provided to ensure the containment closure (quick-closing valves on the containment vessel) be arranged or protected such that the closing of one valve per ventilation duct is possible even in the case of fire.

Note:
In this case, it does not have to be assumed that fires break out simultaneously inside and outside of the containment vessel.

(6) The fans in those ventilation systems the function of which shall be ensured in the case of fire shall be provided with a reliable power supply. An auxiliary power supply in accordance with safety standard KTA 3701 may be considered as sufficiently reliable. The fans do not have to be redundant for fire protection reasons.

(7) Superordinate safety related requirements forbid that the accident filtration systems controlled by the reactor protection system be blocked off by fire dampers. In such cases, a spreading of fire into other fire compartments shall be prevented by the type and routing of the ducts.

4.3.2 Fire Dampers

(1) In cases where spreading of smoke is not permissible, thermal activation of the fire dampers shall be supplemented by other possibilities, e.g., activation by a fire detection and alarm system, manual activation onsite outside of the fire room or area, remote activation from the control room. In this respect, effects from erroneous activations shall be taken into account.

(2) The controls of those fire dampers which, for reasons of safety, may only be activated in the case of fire but shall otherwise remain in the "open" position, shall be designed such that their erroneous activation either does not have to be assumed or that, in individual cases, they can be reopened within a predetermined time period.

Note:
Corresponding details are specified in safety standard KTA 2101.3.

(3) Position indicators shall normally be located in the control room area. At least one group alarm shall be located in plain view of the control room personnel.

4.3.3 Activated Charcoal Filters

Suitable measures shall be taken to prevent the occurrence and spreading of fires of activated charcoal in the filters of the ventilation and exhaust gas systems and to contain such fires.

Note:
Corresponding details are specified in safety standards KTA 2101.2 and KTA 2101.3.

5 Structural and Equipment-related Fire Protection Measures Against Building-external Fires

(1) The fire loads stored as specified on the nuclear power plant site outside of buildings shall be separated from the individual buildings of the nuclear power plant by a sufficient distance or by sufficiently fire-resistant structural elements.

(2) The penetration of smoke and hot fire fumes into the individual buildings via the ventilation systems shall basically be prevented (cf. Construction Supervision Guideline "Ventilation Systems"). The prevention of the penetration of smoke and hot fire gases does not have to be proven in the case of building areas which do not contain equipment of the safety system and which do not have to be occupied by personnel for safety reasons.

(3) Further measures related to the combination of events as specified under Sections 3.2.1, 3.2.2 and 3.2.3 may be disregarded, provided, the requirements in accordance with Sec. 19.1 RSK Guidelines for PWR are met concerning fuel fires in the case of an aircraft crash.

6 Operational Fire Protection Measures

6.1 Responsibilities

(1) In each nuclear power plant one person shall be appointed to be responsible for fire protection. Organizationally, this person shall report directly to the plant management.

(2) The duties of this person shall in particular include the supervision regarding compliance with fire protection measures, e.g., in the case of the storage of combustible materials

or in the course of welding tasks, as well as the supervision of the plant-internal fire brigade, of the maintenance of all equipment-related fire protection measures, of the performance of regular fire drills, of the cooperation with the public fire departments, of the preparation and regular verification of fire alarm and fire fighting plans as well as of verifying that the rescue routes and fire brigade areas are kept clear of obstructions.

(3) The person responsible for fire protection measures shall have a fire protection knowledge at least in accordance with Level B 3 BMI Guideline "Necessary Knowledge".

6.2 Fire Brigade

In accordance with the State codes a plant-internal fire brigade shall be available for the fighting of fires.

6.3 Fire Protection Regulation

A fire protection regulation in accordance with Sec. 6.7 KTA 1201 shall be drawn up as part of the operating manual specifying the measures for fire prevention and fire fighting as well as the substitute measures in situations where the measures of structure-related and equipment-related fire protection are not available as well as the behavior of personnel in case of fire. The fire protection regulation shall also contain information on the location of the supervisory control station in the case of fire.

6.4 Fire Fighting Plans

(1) Fire fighting plans for the nuclear power plant site and for individual structural plant components as agreed upon with the responsible fire department shall be drawn up, e.g., in accordance with DIN 14 095-1, with regard to a rapid orientation and assessment of the situation in the event of fire. These plans shall contain all necessary details for the tactical actions (cf. Sec. 1.3 DIN 14 095-1). They shall, in particular, contain details on the measures regarding the structure-related fire protection, e.g., the number and arrangement of the fire compartments, the manually operated fire dampers, and on the systems and equipment for the detection and fighting of fires.

(2) A copy of the fire fighting plans shall be provided at least in the control room, at the main entrance, with the plant-internal fire brigade and with the person responsible for fire protection.

6.5 Fire Extinguishers

Fire extinguishers shall be placed at convenient locations in accordance with ZH 1/201 and ASR 13/1,2.

7 Tests and Inspections

7.1 Tests Prior to Licensed Construction

(1) The license applicant shall submit the following documents for review and examination before he may receive the respective license:

a) fire protection concept,

b) blueprints with details of the fire protection subdivision and lists with a room-by-room compilation of the existing fire loads and ignition sources – the latter insofar as required under Section 3 – as well as safety-related evaluations of those plant components which could possibly be affected by fire,

c) technical drawings of the areas monitored by automatic fire detection and alarm systems and the areas where fires can be suppressed by stationary fire extinguishing systems,

d) description and – insofar as required – proof of suitability of the fire protection related materials, structural elements and constructions,

e) description of the ventilation systems with details on the schematics, technical drawings, controls concept and – insofar as required – ventilation rates,

f) description of the heat and heat removal equipment as well as proof of their adequate design,

g) description of the fire extinguishing systems as well as proof of their adequate design,

h) description of the fire detection and alarm systems as well as proof of their adequate design,

i) schematic of the areas for the fire brigade.

(2) These documents shall be reviewed to ensure that they are complete, mutually compatible and that the designs they incorporate are suited to the respective functions.

Note:
See also "Compilation of the Documents Required for the Testing of Nuclear Facilities by Construction Supervision Authorities" of November 6, 1981 (GMBl. 1981, page 518).

7.2 Accompanying Inspection

(1) This includes:

a) design review,

b) construction supervision and assembly testing,

c) acceptance and functional testing.

(2) The required tests and inspections are specified in **Table 7-1**. Type and extent of the tests depend on the specific condition of the plant and shall be specified in each individual case. The test instructions shall be presented in good time before acceptance and functional testing.

Note:
See also "Compilation of the Documents Required for the Testing of Nuclear Facilities by Construction Supervision Authorities" of November 6, 1981 (GMBl. 1981, page 518).

7.2.1 Design Review

Design review tests shall be performed as specified in **Table 7-1**.

7.2.2 Construction Supervision and Assembly Testing

(1) The construction materials and structural elements shall be checked in the course of construction and assembly. It shall also be checked that the plant components and equipment are manufactured and erected in accordance with the reviewed documents.

(2) Insofar as the manufacture of the construction materials, structural elements and equipment were already subject to tests in the manufacturing plant, no further testing in this regard is necessary.

7.2.3 Acceptance and Functional Testing

(1) Acceptance and functional test shall be performed as specified in **Table 7-1.**

(2) During acceptance testing, the completeness of the fire protection measures shall be checked.

(3) After repairs and modifications, acceptance and functional testing of the respective structural elements, plants and equipment shall be repeated to the extent necessary.

7.3 Inservice Inspections

(1) The type of tests, the testing intervals and responsibilities regarding inservice inspections are specified in **Table 7-2**. The licensee shall ensure that the tests and inspections are performed properly. Insofar as suitability certificates require shorter testing intervals, these intervals shall be specified in each individual case.

When specifying other testing intervals than the ones listed in **Table 7-2** the experience from inservice inspections as well as the special design characteristics and quality assurance measures required in nuclear power plants shall, in close coordination with the nuclear supervisory authority, be taken into consideration.

(2) A prolongation of the testing interval is permissible, provided, for reasons of, e.g., accessibility, certain tests are possible only during refueling or reactor shutdown. However, the proper authority must consent to the prolongation of operation then required

(3) In accordance with safety standard KTA 1202 testing instructions are required for individual test objects listed in **Table 7-2**. These shall, in particular, specify the pant-related and equipment-related individual testing steps.

Note:
Test requirements are contained in the approvals and test certificates under construction supervision legislation and in the relevant standards and guidelines.

(4) The existing combustible materials shall be checked at least every three years regarding their correspondence with the licensed fire protection concept as specified under Section 3.1.2.2. Within the framework of the fire protection round after every major revision, it shall be checked that the additionally introduced fire loads have been properly removed.

7.4 Removal of Defects

The licensee shall ensure that any defects determined during testing are removed.

7.5 Documentation

(1) Test records shall be prepared as proof of the performance of the tests in accordance with Section 7.3 para.3. These test records shall, in particular, contain an evaluation of the test results, the detected defects, any necessary time limits for the removal of defects and the signature of the tester and the date of the test.

Note:
Details are specified in safety standards KTA 1202 and KTA 1404.

(2) The test records of inservice inspections shall be stored by licensee.

No.	Test Object	Design Review [1]	Construction Supervision / Assembly Testing	Acceptance and Functional Testing
1	Structural Materials	X	X	–
2	Room Isolation Components with Requirements Related to Fire Protection			
2.1	Walls, ceilings and support structures	X	X	X
2.2	Cable and pipe isolation structures	X	X	X
2.3	Fire protection closures (e.g., doors, hatches)	X	X	X
2.4	Other isolating components (e.g., joints, glass windows)	X	X	X
3	Other Equipment-related Fire Protection Measures			
3.1	Specific measures for the separation of redundancies (e.g., encapsulation, coating systems, heat insulation)	X	X	–
3.2	Measures related to reducing the fire hazard of components (e.g., oil pans, splatter protection, special protection of cables)	X	X	–
4	Smoke Removal Systems, with the exception of mechanical smoke removal	X	X	X
5	Fire Alarm System	X	X	X
6	Fire Protection Measures in the Case of Ventilation Systems			
6.1	Ventilation systems with functions in the event of a fire, including functions of the necessary flaps, the corresponding controls and signaling equipment			
	a) equipment-oriented heat and smoke removal systems	X	X	X
	b) ventilation equipment to keep the rescue routes free from smoke	X	X	X
6.2	Fire dampers, smoke protection flaps, smoke removal flaps including the corresponding control and signaling equipment	X	X	X
6.3	Fire resistant ventilation and smoke removal ducts (excluded are concrete ducts)	X	X	X
7	Fire Water Supply	X	X	X
8	Fire Extinguishing System	X	X	X
9	Mobile Fire Extinguishers inside Buildings	X	–	X
10	Mobile Equipment inside Buildings for the Fire Brigade	X	–	X

X Tests performed by proper authority or authorized expert.

– No tests required. In case this applies to the column Acceptance and Functional Testing, the respective acceptance test record shall be created in the course of assembly testing.

1) Insofar as components with a certification of functionality are employed, e.g., with a general certification under building legislation, it is only required that these certificates be presented.

Table 7-1: Testers and Test Objects Regarding Accompanying Inspection

No.	Test Object	Type of Test	Testing Interval		Remarks
			Licensee	Authorized Expert [1)]	
1	Room Closure Components with Requirements Related to Fire Protection				
1.1	Cable isolation structures	S	1 a	2 a	
1.2	Pipe isolation structures	S	2 a	2 a	
1.3	Fire protection closures (e.g., doors, hatches)	F	1 a	2 a	
2	Other Equipment-related Fire Protection Measures				
2.1	Specific measures for the separation of redundancies (e.g., encapsulation, coating systems, heat insulation)	S	2 a	2 a	
2.2	Measures related to reducing the fire hazard of components (e.g., oil pans, splatter protectors, special protection of cables)	S	2 a	2 a	
3	Smoke Removal Systems, with the exception of mechanical smoke removal	F	6 m	1 a	
4	Fire Alarm System				
4.1	Fire detectors	F	1 a	1 a	
4.2	Primary lines	F	3 m	1 a	
4.3	Fire alarm centers including power supply	F	3 m	1 a	
4.4	Control equipment a) for forwarding alarms to the control room and for evaluating the alarms	F	6 m	1 a	
	b) for automatic triggering of fire protection equipment	F	6 m	1 a	
	c) for triggering the forwarding equipment of fire alarms to external authorities	F	6 m	1 a	
4.5	Locking systems of fire protection closures	F	1 m	1 a	
5	*Fire Protection Measures in the Case of Ventilation Systems*				
5.1	Ventilation systems with functions in the event of a fire, including functions of the necessary flaps, the corresponding controls and signaling equipment a) equipment-related heat and smoke removal systems	F	1 a	2 a	
	b) ventilation equipment to keep the rescue routes free from smoke	F	1 a	2 a	
5.2	Fire dampers, smoke protection flaps, smoke removal flaps including the corresponding control and signaling equipment	F	1 a	1 a	
5.3	Fire resistant ventilation and smoke removal ducts (excluded are concrete ducts)	S	1 a	2 a	
6	Fire Water Supply				
6.1	Triggering and power supply of the equipment under No. 6.2	F	1 w	1 a	
6.2	Fire pumps including pressurizer and water make-up equipment	F	1 m	1 a	

No.	Test Object	Type of Test	Testing Interval		Remarks
			Licensee	Authorized Expert [1)]	
6.3	Pressure vessels	in accordance with DruckbehV			
6.4	Pipe network with regard to overall supply capacity	F	2 a	2 a	
6.5	Valves and fittings in the pipe network	F	1 a	2 a	
6.6	Building isolation and penetration valves	F	1 m	1 a	
6.7	Outside hydrants	F	1 a	2 a	
6.8	Hose reels	F	1 a	2 a	Includes measurement of the flow pressure at the highest location (Sec. 9.2 DIN 14 461-1)
7	Spray Water Fire Extinguishing System				
7.1	Remotely controlled valves (including pneumatic and hydraulic valves)	F	6 m	1 a	
7.2	Pipe networks and spray nozzles	S	1 a	1 a	
7.3	Pipe networks and spray nozzles, either, water or pressurized air supply	F	5 a	5 a	
7.4	Alarm system	F	1 w	1 a	
8	Sprinkler Systems				
8.1	Pre-action alarm valve station, rapid openers, rapid air removal	F	6 m	1 a	
8.2	Pipe networks and sprinklers	S	6 m	1 a	
8.3	Alarm system	F	1 w	1 a	
9	Foam Extinguishing System				
9.1	Overall plant including mechanical seals of the admixture facility	S	1 m	1 a	
9.2	Triggering system	F	6 m	1 a	
9.3	Alarm system	F	1 w	1 a	
10	Gas Extinguishing System				
10.1	Overall plant	F	6 m	1 a	
10.2	Triggering and alarm system	F	6 m	1 a	
10.3	Pressure vessel	in accordance with DruckbehV			
11	Mobile Fire Extinguishing Equipment inside the Buildings	S	1 a	2 a	if necessary, additional test in accordance with DruckbehV
12	Mobile Equipment for the Fire Brigade inside the Buildings	S	1 a	2 a	if necessary, additional test in accordance with DruckbehV

F functional test (including visual inspection)

S visual inspection (comparison of the actual condition to the required condition, check with respect to damage-free condition, check of the local measurement locations)

w week(s) testing interval

m month(s) testing interval

a year(s) testing interval; tests are to be performed during refueling in case of inaccessible areas

1) The authorized expert (as defined under Section 2 para. 11) also checks the tests performed by licensee in the form of inspecting the test records of licensee. Tests by experts authorized under other fields of legislation shall be taken into consideration, provided, they correspond to nuclear legislation with respect to type and goal of the tests.

Table 7-2: Responsibilities and Testing Intervals Regarding Inservice Inspections

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.

Atomgesetz		Act on the peaceful utilization of atomic energy and the protection against its hazards (Atomic Energy Act) of December 23, 1959 (BGBl. I, p. 814) as amended on July 15, 1985 (BGBl. I, p. 1565), most recently changed by law on April 6, 1998 (BGBl. , p. 694)
DruckbehV		Ordinance for pressure vessels, pressurized gas bottles and filling facilities (Pressure Vessel Ordinance – DruckbehV) of April 21, 1989, (BGBl. I, p. 843) most recently amended by Law of June 23, 1999, (BGBl. I, p. 1435)
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)
ArbStättV		Ordinance on working places (Working Place Ordinance – ArbStättV) of March 20, 1975 (BGBl. I, p. 729) most recently changed by law of December 4, 1996 (BGBl. I, p. 1841)
VBG 30	(01/87)	Accident prevention regulation – Nuclear power plants
MBO	(10/81)	Specimen building code (Special Commission on Construction Surveillance of the ARGEBAU)
Construction Supervision Guideline "Ventilation Systems"	(01/84)	Construction supervision guideline on fire protection requirements regarding ventilation systems (initial draft version)
BMI-Guideline "Necessary Knowledge"	(10/80)	Guideline relating to the assurance of the necessary knowledge of the persons otherwise engaged in the operation of nuclear power plants of October 30, 1980 (GMBl. 1980, p. 652)
RSK-Guidelines for PWR	(10/81)	RSK-Guidelines for Pressurized Water Reactors, 3rd edition of October 14, 1981 (BAnz. No. 69 of April 14, 1982, Supplement No. 19/82)
Incident Guidelines	(10/83)	Guidelines on the evaluation of the design of nuclear power plants with pressurized water reactors against incidents in terms of Sec. 28 para. 3 Radiological Protection Ordinance (Incident Guidelines) of October 18, 1983 (BAnz. No. 245 of December 31, 1983)
Recommendation – Accident Management Measures	(10/77)	Recommendations on the planning of accident management measures by the operator of nuclear power plants of December 27, 1976 (GMBl. 1977, p. 48), most recently changed by ordinance of October 18, 1977 (GMBl. 1977, S. 664)
KTA 1201	(06/98)	Requirements for the operating manual
KTA 1202	(06/84)	Requirements for the testing manual
KTA 2201.1	(06/90)	Design of nuclear power plants against seismic events Part 1: Principles
KTA 2201.6	(06/92)	Design of nuclear power plants against seismic events Part 6: Post-seismic measures
KTA 3701	(06/99)	General requirements for the electrical power supply in nuclear power plants
DIN 3221	(01/86)	Fire hydrants, under ground
DIN 3222	(01/86)	Fire hydrants, above ground
DIN 4102-1	(05/98)	Fire behaviour of building materials and building components - Part 1: Building materials; concepts, requirements and tests
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 14 095	(08/98)	Ground plans of buildings for fire brigade use
DIN 14 210	(11/82)	Water pool for fire fighting
DIN 14 220	(04/91)	Fire wells
DIN 14 230	(04/91)	Underground water-tanks for fire fighting
DIN 14 461-1	(02/98)	Delivery valve installation - Part 1: Hose reel with semi-rigid hose
DIN 14 461-6	(06/98)	Delivery valve installation - Part 6: Dimensions of cabinets and installation of hose reels with lay-flat hoses according to DIN EN 671-2
DIN EN 54-1	(10/96)	Fire detection and fire alarm systems - Part 1: Introduction; German version EN 54-1:1996
DIN EN 671-1	(02/96)	Fixed firefighting systems - Hose systems - Part 1: Hose reels with semi-rigid hose; German version EN 671-1:2001
DIN EN 671-2	(02/96)	Fixed firefighting systems - Hose systems - Part 2: Hose systems with lay-flat hose; German version EN 671-2:2001
ASR 13/1, 2	(06/97)	Fire extinguishing equipment (BArbBl. 1997, Nr. 7/8, p. 70-73)
ZH 1/201	(1996)	Rules for the equipment of work places with fire extinguishers

Safety Standards

of the
Nuclear Safety Standards Commission (KTA)

KTA 2101.2 (12/2000)

Fire Protection in Nuclear Power Plants
Part 2: Fire Protection of Structural Plant Components

(Brandschutz in Kernkraftwerken
Teil 2: Brandschutz an baulichen 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 2: Fire Protection of Structural Plant Components**	KTA 2101.2

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 +49-221-94373603).

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 structure-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 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 exemptions shall be handled on a case-by-case basis in accordance with the procedures specified in these individual regulations.

(4) This safety standard KTA 2101.2 supplements the safety standards:

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

KTA 2101.3 Fire protection in nuclear power plants; Part 3: Fire protection of mechanical and electrical plant components

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 surrounding these plant components and
c) the plant personnel.

Note:
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 pipe and cable ducts or channels between the aforementioned buildings.

2 Definitions

Note:
Additional definitions are given in safety standards KTA 2101.1 and KTA 2101.3.

(1) Acceptance and Functional Testing
Acceptance and functional testing comprises testing and evaluation of the constructed and assembled components and systems as well as their functional behavior.

(2) Assembly Testing
Assembly testing is the performance of tests by the manufacturer or at the construction site of the finished components and systems or those still under construction to show that they are in conformance with the design-reviewed documents.

(3) Smoke Exhaust Dampers
Smoke exhaust dampers are devices that are opened in the event of fire and are intended for heat and smoke removal.

(4) Smoke Removal Conduits
Smoke removal conduits are conduits, e.g. ducts and channels, for the removal of smoke or heat in the event of fire.

(5) Protected Corridor
A protected corridor is a corridor that is meant to be used as escape route. It leads to the necessary stairways or from the necessary stairways to the outside.

(6) Ventilation Conduits
Ventilation conduits are conduits, e.g. ducts and channels, meant for the transport of air.

(7) Smoke Dampers
Smoke dampers are active isolating devices against smoke that are triggered by the fire variable "smoke".

(8) Airlock Annexes
Airlock annexes are rooms arranged in advance of the personnel locks (in accordance with safety standard KTA 3402) inside the reactor containment vessel of a pressurized light-water reactor. They are intended to be used as rescue route.

(9) Necessary Stairway
A necessary stairway is a stairway that contains the staircase needed to get to a higher-than-ground-level building floor and that is intended to be used as rescue route.

(10) Design Review
Design review is the evaluation of the documents that are prepared for manufacturing, e.g., schedules and plans, written instructions, technical drawings and calculations, with respect to whether or not they meet the provisions of the license.

3 Design of Structure-related Fire Protection Measures

(1) Insofar as no prior experience is available, it shall be confirmed experimentally or analytically, or by analogy or plausibility considerations that the structure-related fire protection measures will withstand the fire effects determined in accordance with Sec. 3.1.2.3 KTA 2101.1 without losing their

function regarding fire protection (e.g., stability, room isolation).

(2) In the case of an analytical validation it is permissible to use simplified procedures, provided, the calculations lead to conservative results.

Note:
One such conservative procedure is presented in Appendix A.

(3) In the case of analogy considerations, they shall be based on referential results of experimental or analytical confirmations that were performed for comparable structure-related fire protection measures (comparable to, e.g., type of construction, building materials, dimensions) und for comparable loadings (e.g., temperature effects, operational loading, if necessary additional loading due to design basis accidents (incidents)).

(4) Plausibility consideration may be performed on the basis of the design of structure-related fire protection measures for other load cases with the objective of proving that the actual design can be considered as ensured to be sufficiently safe.

(5) It is not required to prove the fire resistance rating of structure-related fire protection measures during earthquakes, provided, they are designed in accordance with KTA 2201.1 for the design-basis earthquake.

(6) If additional requirements in accordance with Sec. 3.1.1 para. 6 KTA 2101.1 must be considered in the design (e.g., gas leak tightness, lower component temperature on the far side of the fire) then the determination of the fire resistance rating of the components shall be based also on these requirements.

The testing guidelines and criteria in accordance with technical standards series DIN 4102 shall be applied, however, only after adjustment to the above requirements.

(7) If additional events in accordance with Sec. 3.1.1 para. 7 KTA 2101.1 must be considered in the design, then the determination of the fire resistance rating of the components shall be based also on these events.

(8) Those structure-related fire protection measures the fire protection function of which must be ensured even after earthquakes shall be designed in accordance with Sec. 3.2.3 para. 2 KTA 2101.1.

4 Location and Accessibility of Buildings of Nuclear Power Plants

4.1 General Principles

(1) The buildings of nuclear power plants shall be arranged taking operational and, additionally, the following requirements into consideration:

a) the fire protective separation by the distance between buildings,

b) the rapid and safe escape and rescue of persons in case of an emergency and

c) the access ways for danger aversion missions.

(2) The requirements in accordance with DIN 14 090 shall basically be applied and those specified under Sections 4.2 through 4.5 shall additionally be applied.

(3) Deviating specifications regarding the location and accessibility of the buildings require the consent of the proper authorities in the course of the licensing procedure.

(4) In planning accident management measures, the location of the personnel assembly points shall be specified such that they present no hindrance to the mission of the fire brigade.

4.2 Access Roads

(1) Basically all surface areas on the site of the power plant that are used for vehicular traffic shall be designed at least as a fire brigade surface area in accordance with DIN 14 090.

Exceptions are permissible in the case of remote vehicular surface areas, e.g., parking lots, provided, they have no significance with respect to the access to buildings or plant components. In case they have a reduced load-carrying capacity in accordance with DIN 14 090 they shall be marked accordingly.

(2) Buildings with safety-related system and plant components shall basically be accessible via two independent access routes that are at least 6 meters wide. Exceptions are permissible in the case of access routes to remote buildings with a low fire load density, e.g., the auxiliary service water pump building.

(3) The width of the access route may be reduced to a minimum of 3.5 meters if plant engineering so requires. However, the length of such bottlenecks shall be limited to a maximum of 40 meters.

4.3 Access Ways

(1) In view of rescue and danger aversion missions, it shall be possible to open the access ways from the outside and secure them in the open position during emergencies. This also applies to inside access ways to enclosed building regions.

(2) The doors of the access ways dedicated to rescue and danger aversion missions shall open to their full width and basically in the direction of escape. Exceptions are permissible for reasons of plant engineering, e.g., in the case of rooms where the ventilation system keeps a below-atmospheric pressure or if only a small number of persons have to depend on these doors.

4.4 Fire Brigade Engagement Areas

(1) Insofar as the necessary rescue routes in buildings lead to windows and roof surfaces that can be used for rescue operations, individual fire brigade engagement areas in accordance with DIN 14 090 shall be assigned to these windows and roof surfaces for the positioning of rescue hoist vehicles.

(2) Fire brigade engagement areas may be integrated into driveways such that, in accordance with DIN 14 090, a passage of at least 5 meters remains next to the fire brigade engagement area.

4.5 Free Movement Areas

(1) A free movement area with an area of at least 7 meters by 40 meters shall be assigned to each of the necessary access point of the buildings with regard to rescue and danger aversion missions. The distance between the free movement area and the assigned access points shall normally not exceed 25 meters.

(2) The free movement areas may be integrated into driveways such that, in accordance with DIN 14 090, a driveway of at least 3 meters remains free next to the free movement area.

(3) Walk ways or other similarly paved ways that are bordered off by curb stones may be integrated up to a width of 2 meters into the free movement areas.

5 Fire Compartments and Fire Sub-compartments

5.1 Fire Compartments

(1) Fire compartments shall be established in accordance with Sec. 4.1.3 KTA 2101.1.

(2) If systems engineering or functional and operational requirements make it necessary that the size of a fire compartments exceeds the size specified by building law it is, then, permissible (in accordance with Sec. 4.1.3 para. 2 KTA 2101.1) to achieve the required fire protection by equivalent measures, e.g., by creating fire sub-compartments as specified under Section 5.2, by additional equipment-related fire protection measures, or by a combination of these measures. This applies, e.g., to the reactor building and to the turbine building of boiling water reactors.

5.2 Fire Sub-compartments

(1) Within the fire compartments the following sub-sections, e.g., shall be created as fire sub-compartments taking para. 3 of this section and Sec. 4.1.3 para. 3 KTA 2101.1 into account,:

a) rooms for electronic data processing equipment and their under-floor cable sections,
b) rooms for switch gear and their under-floor cable sections,
c) rooms for electronic equipment and their under-floor cable sections,
d) rooms for emergency power generation facilities and their fuel depots, redundancies of the emergency power supply facilities,
e) rooms for redundant safety-related systems and plant components,
f) rooms with storage vessels and facilities for lubrication oil, turbine oil and other flammable liquids,
g) cable ducts or channels and cable wells, insofar as they are not part of a room,
h) cable floors,
i) pool for new fuel assemblies,
j) rooms for transformers with flammable liquids inside of buildings,
k) rooms for the external oil supply (oil storage vessel including auxiliary equipment). In the case of boiling water reactors, this room shall be located outside of the control rod drive room.
l) rooms in which more that 3 m³ of activated charcoal are stored,
m) rooms for fuel oil storage tanks,
n) rooms for conditioning combustible waste material including the corresponding storage rooms.

(2) Within the fire compartments the following sub-sections, e.g., shall normally be created as fire sub-compartments taking para. 3 of this section and Sec. 4.1.3 para. 3 KTA 2101.1 into account,:

a) rooms for the fuel oil day tanks,
b) rooms for closed containers for combustible radioactive substances.
c) rooms for activated charcoal.

(3) Accessible pipe and cable ducts or channels that are longer than 50 meters shall basically be subdivided into fire sub-compartments that are, as far as possible, equal in length. If the channels do not contain any combustible materials or if they are equipped with a stationary fire extinguishing system (cf. Sec. 4.2.4 para. 1 KTA 2101.1) then a subdivision is required only if the channel is longer than 100 meters. When creating the subdivision, personnel protection shall be taken into consideration.

(4) The control room in accordance with Sec. 3 KTA 3904 together with its functional areas and the corresponding cable floor shall belong to at least one fire sub-compartment. The document area and the personnel rest area shall be separated from the control room as fire sub-compartments in the fire resistance class F 90-A in accordance with DIN 4102-2. The control room annex shall normally be separated into an individual fire sub-compartment in the fire resistance class F 30-A in accordance with DIN 4102-2.

(5) The emergency control center including annex room and the corresponding conduit room shall be designed as at least one fire sub-compartment in the fire resistance class F 90-A in accordance with DIN 4102-2.

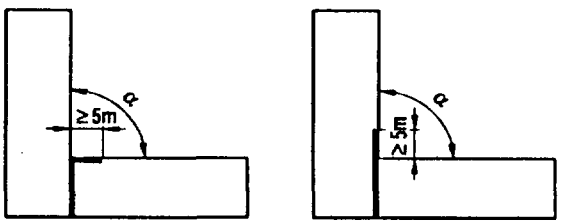
5.3 Measures Regarding Adjacent Buildings and Building Corners

5.3.1 Adjacent Buildings

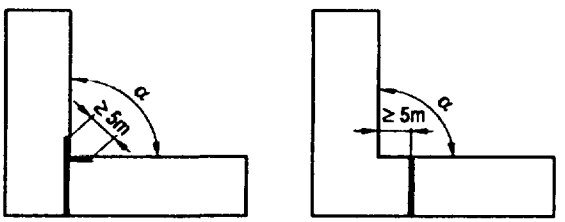
If the distance between adjacent buildings is smaller than 5 meters, one of the opposing external walls shall be designed as a fire wall in accordance with DIN 4102-3.

5.3.2 Building Corners

The corner between building components that meet under an angle α smaller than or equal to 120 degrees and have to be separated by a fire wall shall be designed as shown in **Figure 5-1.**



The fire wall at the inside corner shall be extended in either of the two directions to a length ≥ 5 meters.



The fire wall shall be extended in both directions.

The fire wall shall be arranged at a distance of ≥ 5 meters away from the inside corner.

Figure 5-1: Building Corners

5.3.3 Roofs of Lower Buildings or Building Components

(1) The roof levels or the roofs of lower building parts or of adjacent lower buildings that are closer than 5 meters from the external walls of the larger building parts or buildings shall be designed to be fire resistant at least with a fire resistance rating F 90-A in accordance with DIN 4102-2.

(2) The measures under para. 1 are not required if the adjacent external wall of the higher building is designed as a fire wall in accordance with DIN 4102-3.

6 Structural Elements Enclosing Fire Compartments and Fire Sub-compartments

6.1 Structural Elements Enclosing Fire Compartments

(1) All structural elements enclosing fire compartments including their support and bracing structures shall be designed to be sufficiently fire resistant, however, at least with a fire resistance rating F 90-A in accordance with DIN 4102-2.

(2) Walls that enclose fire compartments toward adjacent buildings or building parts shall basically be designed as continuous fire walls in accordance with DIN 4102-3.

It is permissible to use overlapping instead of continuous fire walls if this is necessary with respect to the use of the building, provided, they are sufficiently fire resistant and are, however, at least in the fire resistance class F 90-A in accordance with DIN 4102-2. These walls shall basically be constructed together with hermetically closed ceilings that are at least in the same fire resistance class and that shall, additionally, meet the requirements in accordance with Sec. 4.2.4 DIN 4102-3.

If systems engineering requires openings in these ceilings, these openings shall be closed off as if they were openings in fire walls.

(3) If operating activities in a fire compartment bring about an increased fire risk (e.g., increased fire load density, increased danger of ignition, unfavorable ventilation conditions, difficult accessibility or for the protection of equipment of the safety system), a higher fire resistance capability (cf. Sec. 4.2.5 DIN 4102-3) may become necessary for the structural elements under paras. 1 and 2. These measures shall be confirmed analytically as specified under Section 3.

(4) Openings and structural joints in the structural elements enclosing fire compartments shall be designed as specified under Section 6.3.

(5) Fire compartment enclosing walls and ceilings the fire protection function of which must be ensured in accordance with Section 3.1.2.2 KTA 2101.1 even after earthquakes shall be certified in accordance with Section 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
Requirements regarding procedures for the certification of earthquake safety of structural plant components are dealt with in KTA 2201.3 (in preparation).

6.2 Structural Elements Enclosing Fire Sub-compartments

(1) Fire sub-compartments enclosing walls and ceilings including the support structures and bracing structures shall basically be designed to correspond to fire resistance class F 90-A in accordance with DIN 4102-2.

Walls shall basically meet the requirements in accordance with Sec. 4.2.4 DIN 4102-3. Exemptions are permissible in the case of, e.g., walls of the control room annex and walls for the partitioning of room areas with redundant safety-related equipment.

(2) Higher fire resistance classes may be required and lower fire resistance classes may be permissible. Higher requirements would apply if they are necessary

a) due to an increased fire risk, e.g., increased fire load density, increased danger of ignition, unfavorable ventilation conditions or difficult accessibility,

b) for the protection of equipment of the safety system.

(3) Openings and structural joints in building elements enclosing fire sub-compartments shall be designed as specified under Section 6.3.

(4) Fire sub-compartment enclosing walls and ceilings the fire protection function of which must be ensured in accordance with Section 3.1.2.2 KTA 2101.1 even after earthquakes shall be certified in accordance with Section 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
Requirements regarding procedures for the certification of earthquake safety of structural plant components are dealt with in KTA 2201.3 (in preparation).

6.3 Closures for Openings and Joints in Structural Elements Enclosing Fire Compartments and Fire Sub-compartments

6.3.1 General Principles

(1) The fire resistance rating of the closure of openings and structural joints shall basically have the same fire resistance rating as required for the enclosing structural elements. Deviating requirements are permissible in the case of fire sub-compartments, provided, an analytical confirmation as specified under Section 3 is presented.

(2) Insofar as the closures of openings must, in addition to fire protection, meet requirements regarding

a) radiation protection,

b) leak tightness,

c) mechanical stability with respect to external events and plant-internal design basis accidents (incident)

d) plant security

and which, thereby, might lead to a reduction of the fire resistance capability of structural elements, then the fire protection shall be ensured by other equivalent means.

(3) Closures of openings and structural joints the fire protection function of which must be ensured in accordance with Section 3.1.2.2 KTA 2101.1 even after earthquakes shall be certified in accordance with Section 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
Requirements regarding procedures for the certification of earthquake safety of mechanical and electrical components are dealt with in KTA 2201.4

(4) It shall be confirmed that the closures specified under Sections 6.3.2 through 6.3.6 are suitable with regard to the requirements under paras. 1 through 3. In the case structural elements that were designed based on other than the standards introduced under construction supervision legislation, their suitability shall be considered as certified if they have a general construction supervision permit or an approval for the individual application, provided, no other requirements are specified in this safety standard.

6.3.2 Fire Protection Closures (Fire Protection Doors, Flaps, Elevator Shaft Doors)

(1) Fire protection doors shall basically be kept in the closed position. If they should be kept in the open position they shall be equipped with close-and-retain systems that are generally certified under the construction supervision code.

(2) The following applies to the certification of their safety against earthquakes:

The functional tests performed in the course of their approval under construction supervision legislation result in dynamic loadings that are comparable to those of an earthquake. Insofar as these dynamic loads were registered during the tests and that it can be shown that they will not be exceeded by an earthquake at the installation location, there is no need for an additional certification of safety against earthquakes.

(3) Elevator shaft doors shall be designed in accordance with standards under construction supervision legislation, or they shall have an approval under the construction supervision code or an approval for the individual application.

6.3.3 Cable Fire Shields

(1) As a precaution against a fire transmittal by bundled cables penetrating through enclosing structural elements, construction-supervision approved cable fire shields (tests in accordance with DIN 4102-9) shall be used.

Cables are considered as being bundled when more than two cables lie next to or over each other and, thereby, form a hollow gusset.

(2) The proper functioning of cable fire shields, both, during fire and after earthquakes shall be certified in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
Structural details regarding the design of cable ducts are dealt with under Section 9.

Relative distortions at the bushing in direction of the cable penetration due to the dynamic loading in the course of earthquakes shall be limited by structural means (arrangement of the fixed point) such that the fire resistance rating of the cable bushing is not impermissibly reduced (cf. Section 9).

(3) The bushings of cable penetrations through the reactor containment vessel shall be designed in accordance with Sec. 4.7 KTA 3403.

(4) In the case of the penetrations of single electrical cables, the remaining hollows shall be blocked off with non-combustible mineral materials.

6.3.4 Pipe Penetrations

(1) Combustible pipes that penetrate enclosing structural elements shall be equipped with construction-supervision approved pipe bushing systems; other pipes shall be equipped with bushing systems tested in accordance with DIN 4102-11.

(2) In the case of water and waste water pipes less than or equal to DN 150 no analytical confirmation with certification nor special measures are required, provided, the space between the pipes and the remaining free cross-section is completely filled with an non-combustible dimensionally stable material. If mineral fibers are used in the case of components from mineral materials, e.g. mortar or concrete, then the melting temperature in accordance with Sec. 3.14.2.3 DIN 4102-4 of the mineral fibers shall be at least 1000 °C. This does not apply to pipes made of fiber cement or aluminum.

(3) Proper functioning of the pipe penetrations shall be certified for the event of fire as well as for the loading during specified normal operation and after earthquakes in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
With respect to temperature induced changes of the pipe length, the tests in accordance with DIN 4102-11 take only a limited pipe length into consideration.

(4) In the case of pipes penetrating structural elements with a specified fire resistance rating that, however, are not designed against the loading from a one-sided fire-induced failure of the pipes, the pipes on both sides of the penetration shall be secured in their position by corresponding anchoring devices made of non-combustible materials, e.g., steel hanging devices.

6.3.5 Installation Ducts and Channels

(1) Deviating from Sections 6.3.3 and 6.3.4, it is permissible to also use installation channels to lead pipes and bundled cables through story ceilings or walls meeting fire protection requirements, provided, a test in accordance with DIN 4102-11 proves that neither fire nor smoke will be transmitted.

(2) Cables outside of cable ducts or channels that supply safety related components shall normally be separated by enclosing structural elements of fire sub-compartments from neighboring pipes that lead combustible materials.

(3) Installation ducts and channels the fire protecting function of which must be ensured in accordance with Sec. 3.2.3 KTA 2101.1 even after earthquakes shall be certified in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

Note:
Requirements regarding procedures for the certification of earthquake safety of mechanical and electrical components are dealt with in KTA 2201.4

6.3.6 Joints

(1) In the case that structural elements for enclosing fire compartments contain expansion or movement joints, the joint packing shall consist of an non-combustible material in class A in accordance with DIN 4102-1. The joints shall be filled up with a joint sealant in accordance with DIN 52 460 that shall be at least in material class B 1 in accordance with DIN 4102-1.

(2) In the case that structural elements for enclosing fire sub-compartments contain expansion or movement joints, the joint packing shall basically consist of non-combustible materials of class A in accordance with DIN 4102-1. Exemptions are the joint constructions with a suitability certification as specified under para. 5.

(3) The joint packing shall be installed such that the volume of the joint stays filled in the event of fire and under the expected movements during specified normal operation and after earthquakes in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

(4) The following types of joint packing are permissible:

a) in the case of expansion and movement joints, mineral fiber or foam matting that later is folded and pressed into the prefabricated joints. (Examples, cf. **Figure 6-1** and **Figure 6-2**)

b) in the case of all other joints, mineral fiber sheets in accordance with Sec. 4.4.2.3 DIN 4102-4 and mineral fiber braids with comparable characteristics.

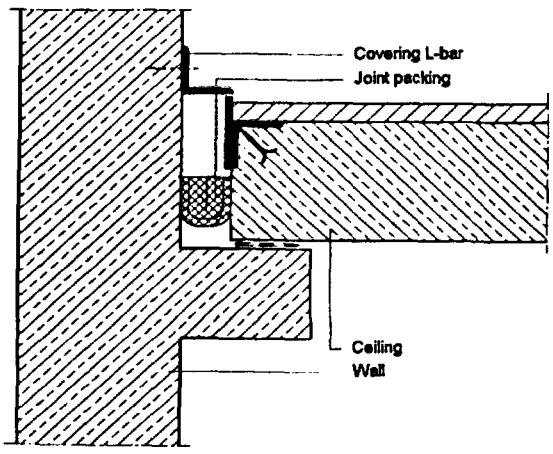


Figure 6-1: Design example for a ceiling joint (movement joint)

(5) The suitability of other joint designs may be confirmed by

a) a test certificate in accordance with DIN 4102-2,

b) a certification in accordance with DIN 4102-4 or

c) an expert statement from an authorized materials testing institution.

(6) In case a combustible material in class B 1 in accordance with DIN 4102-1, e.g. cellular polystyrene foam plates in accordance with DIN 18 164-1 and DIN 18 164-2, is used for technical reasons (concrete pressure) to achieve a defined joint width between two buildings, this material shall be removed from the joint after concreting to a depth corresponding to the suitability proof specified under para. 5 and shall be replaced by a suitable joint packing of non-combustible materials in class A in accordance with DIN 4102-1 as specified under para. 4 above.

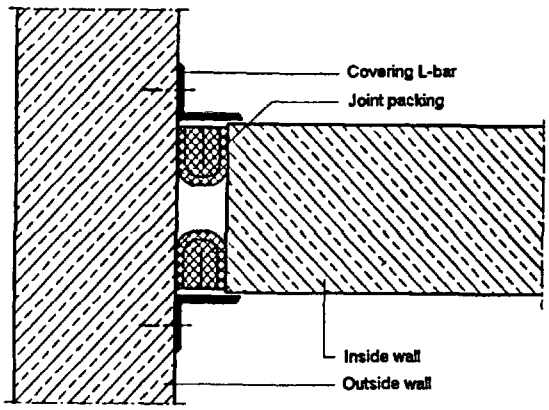


Figure 6-2: Design example for a wall joint

6.4 Structure-related Measures in the Case of Transformers

(1) Transformers filled with flammable isolating liquids located inside of buildings shall be separated from adjacent rooms by fire resistant walls and ceilings that correspond at least to the fire resistance class F 90-A in accordance with DIN 4102-2.

(2) Precautionary measures shall be taken with respect to the main and auxiliary power transformers that would help in preventing a fire from spreading into the switchgear building.

(3) Transformers filled with flammable isolating liquids and a power rating larger than or equal to 1 MVA located outside of buildings shall be separated from each other by fire resistant walls that correspond at least to the fire resistance class F 90-A in accordance with DIN 4102-2 and that are dimensioned in correspondence to DIN VDE 0101, however, at least as follows:

Height: extending beyond the top edge of the transformer vessel including the expansion vessel: by at least 1.0 meters

Depth: extending to the front and, in the case of a free standing installation, also to the back: by at least 1.5 meters.

(4) The walls of buildings adjacent to transformers filled with flammable isolating liquids shall be designed as walls enclosing fire compartments up to a height of either 5 meters above the top edge of the transformer vessel including the expansion vessel or up to an equivalent ceiling above the transformer and, horizontally, to a length of 5 meters beyond either side of the transformer lateral dimension. Wall surfaces extending beyond these dimensions shall correspond at least to the fire resistance class W 90-A in accordance with Sec. 5.2 DIN 4102-3.

6.5 Measures to Counter Fire Flashover Between External Structural Elements

6.5.1 External Walls

(1) External walls shall consist of non-combustible building materials of Class A in accordance with DIN 4102-1. This also applies to barrage structures and glass surfaces except for the sealants, flashings and sunshades.

(2) The external walls of those buildings shall be protected against fire where fire loads (that are specified to be normally stored on the nuclear power plant site outside of buildings) are stored at an insufficient distance from the buildings.

The fire resistance rating of the structural elements shall be certified in accordance with Sec. 3.1.2.3 KTA 2101.1 or the structural elements shall have a fire resistance rating of F-90.

(3) The structural elements in external walls between adjacent floors shall be arranged such that the distance for a fire flashover is at least 1 meter; these components shall correspond to at least the fire resistance class W 90-A in accordance with Sec. 5.2 DIN 4102-3 and, together with the fixtures and supports, shall consist of non-combustible materials of Class A in accordance with DIN 4102-1. It is, instead, permissible to position structural elements with a fire resistance rating of F 90-A in accordance with DIN 4102-2 between the floors that extend horizontally to at least 1.5 meters beyond the external wall.

A larger fire flashover distance is necessary between stories that have a fire load density requiring a larger fire resistance class than F 90 for the enclosing structural elements.

(4) The facing of external walls including fixtures and supports as well as damming shall consist of non-combustible building materials of Class A in accordance with DIN 4102-1.

6.5.2 Roofs

(1) The support structure of the roofs and the roof sheathing shall consist of non-combustible building materials of Class A in accordance with DIN 4102-1.

(2) The direct distance between roof openings belonging to different fire compartments or fire sub-compartments and that are unprotected from the standpoint of fire protection shall be at least 5 meters.

(3) The roof skin shall normally consist of non-combustible building materials of Class A in accordance with DIN 4102-1. The roof skin shall correspond at least to a hard roofing in accordance with DIN 4102-7.

7 Structural Elements for Rescue Routes

7.1 Structural Requirements

7.1.1 General Principles

(1) The following requirements apply to rescue routes in safety-related areas of the plant. Additional requirements from other technical standpoints remain unaffected.

(2) In the case that protected corridors, necessary stairways and air lock annexes must serve as required safety-related access ways (e.g., as fire access route for the manual fire fighting mission in the event of fire after the design-basis earthquake or to reactivate fire protection measures immediately after the earthquake), then their enclosing structural elements including doors shall, additionally be designed against earthquakes as specified under Section 6.1 para. 5.

7.1.2 Protected Corridors

(1) Walls and ceilings of the protected corridors shall correspond to the fire resistance class F 90-A in accordance with DIN 4102-2.

(2) Closing elements of openings from the protected corridors to adjacent rooms shall basically have the same fire resistance class as the enclosing structural elements of the corridors themselves.

(3) A lower fire resistance class is permissible for closing elements of openings to rooms with a definite fire risk. In this case they shall be validated analytically as specified under Section 3 and they shall be designed to be at least fire retardant.

(4) Doors and flaps shall be of a self-closing design.

7.1.3 Necessary Stairways

(1) The walls and ceilings of necessary stairways shall be designed to be fire resistant (fire resistance rating F 90-A in accordance with DIN 4102-2). Furthermore, the walls shall be as deep as a firewall (cf. Sec. 4.2.4 DIN 4102-3).

(2) Closing elements of openings from the necessary stairways to adjacent rooms shall basically be designed to be fire resistant. A lower fire resistance class is permissible for closing elements of openings to rooms with a definite fire risk. In this case they shall be validated analytically as specified under Section 3 and shall be designed to be at least fire retardant.

Doors from protected corridors to necessary stairways shall be smoke control doors in accordance with DIN 18 095-1 or designed to be at least fire retardant and self-closing.

(3) The requirements under para. 2 do not apply to openings leading to the outside. When necessary stairways are arranged in front of the external wall of buildings, an angle is created to the outside wall. In this case the distance to unprotected openings shall be designed as equal to the safety distance as specified under Section 5.3.2.

(4) Stair cases and landings shall be enclosed and fire resistant. Breakthroughs for pipelines are permissible. Banisters shall be designed of non-combustible materials. Wooden handrails with a cross-section limited to its purpose are permissible.

7.1.4 Air Lock Annexes

(1) The walls and ceilings of air lock annexes shall correspond to the fire resistance class F 90-A in accordance with DIN 4102-2.

(2) In well founded cases, lower fire resistance classes are permissible for flaps. They shall be validated analytically as specified under Section 3.

(3) Doors and flaps with a comparable task designation shall be designed to be self-closing.

(4) Doors to necessary stairways shall be smoke tight in accordance with DIN 18 095-1.

7.2 Joints in Enclosing Structural Elements

Joints in enclosing structural elements of the rescue routes shall be designed as specified under Section 6.3.6.

7.3 Flooring, Lining, Damming and Coating

(1) The lining and damming of rescue routes shall be of non-combustible materials of Class A in accordance with DIN 4102-1.

(2) The flooring materials shall be at least flame retardant in accordance with class B 1 of DIN 4102-1 and, with regard to smoke development, shall correspond to class A 2 of DIN 4102-1.

(3) The decontaminable coatings of walls, ceilings and floors shall be at least flame retardant in accordance with class B 1 of DIN 4102-1 and, with regard to the development of heat and smoke, shall correspond to class A 2 of DIN 4102-1.

8 Ventilation Systems, Heat and Smoke Removal Systems

8.1 General Principles

(1) In the case that fire dampers are installed in the ventilation systems that, in accordance with KTA 3601, must be leak tight, these fire dampers shall not have impermissibly adverse effects on the leak tightness of the system.

(2) Leak tight ventilation systems also serving fire protection purposes shall be designed such that the recurrent leakage tests in accordance with KTA 3601 can be performed. These tests shall not have enduring adverse effects on fire protection.

(3) Structural separations of the redundancies of ventilation systems shall be designed in accordance with Sec. 4.1.3 para. 8 KTA 2101.1.

8.2 Ventilation Conduits, Fire Dampers and Smoke Dampers

(1) Pipes, adapter fittings, ducts and channels of ventilation conduits in a specified fire resistance class shall basically be designed of non-combustible materials. Exceptions are permissible, provided, the purpose is to remove corrosive gasses (e.g. from battery rooms and laboratories), the materials used are at least flame retardant in accordance with class B 1 of DIN 4102-1 and the necessary fire dampers are suited for the purpose.

(2) With regard to certifying the required fire resistance, the pipes, adapter fittings, ducts and channels of ventilation con-

duits including their connecting and mounting elements shall basically be designed in accordance with DIN 4102-4. Instead it is permissible to present a test certificate or expert report by a testing institute recognized for performing tests in accordance with DIN 4102-6.

(3) The following applies to ventilation conduits of the ventilation system supplying the control room and emergency control center:
In case air ducts of the required ventilation system lead through the fire affected section, they shall be sufficiently fire resistant, shall however correspond at least to the fire resistance class L 90 in accordance with DIN 4102-6. If the design must meet additional requirements (e.g., lower temperature on the far side of the fire, gas leak tightness), these shall be considered in determining the fire resistance rating of the structural elements.

(4) Ventilation conduits and their mountings that, in accordance with Sec. 3.1.2.2 KTA 2101.1, must retain their fire protection function even after an earthquake shall be certified in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

(5) Fire dampers as well as smoke dampers shall carry a construction supervision test mark. Installation and use of the closures shall correspond to the requirements of the individual test certificates.

8.3 Smoke Removal Conduits and Smoke Exhaust Dampers

(1) Smoke removal conduits that penetrate walls or ceilings with a specified fire resistance rating shall themselves be fire resistant in correspondence to these structural elements.

(2) Smoke removal conduits shall consist of non-combustible materials of Class A in accordance with DIN 4102-1.

(3) Smoke removal conduits shall be sufficiently leak tight and resistant to deformation at the expected temperatures and at the pressure differences caused by the smoke removal ventilator. The design shall basically consider a temperature of 900 °C. Deviations are permissible if it is validated analytically

a) that the smoke will cool off along the smoke removal conduits or

b) that lower temperatures are expected inside the fire room.

(4) Smoke removal conduits shall basically be designed such that, within the area where the smoke should be removed, they are sufficiently resistant to deformations up to a temperature of at least 900 °C. In the case of rooms up to a surface area of 400 m² this resistance to deformation is not required, provided, it is ensured that the smoke removal cross-section at the enclosing wall stays to size in the event of fire. The required confirmation shall be presented in the form of a test certificate or of an expert report on a test performed in accordance with DIN 4102-6.

(5) Smoke exhaust dampers are permissible only in smoke removal conduits and may be opened only for the purpose of smoke removal. They shall be interlocked in the open position.

(6) Smoke exhaust dampers shall have at least the same fire resistance rating as required for the smoke removal conduits in which they are installed.

(7) An approval for the individual application by the supreme construction supervision authority is required as confirmation of suitability.

(8) Smoke exhaust dampers that, in accordance with Sec. 3.1.2.2 KTA 2101.1, must retain their fire protection function even after an earthquake shall be certified in accordance with Sec. 3.2.3 KTA 2101.1.

With respect to earthquakes and subsequent fires, the requirements in accordance with Sec. 3.2.2.1 KTA 2101.1 shall be applied.

8.4 Heat and smoke Removal

(1) The heat and smoke removal required in accordance with Sec. 4.2.5 KTA 2101.1 may be performed by

a) ventilation systems remaining functional in the event of fire or

b) mechanical smoke removal systems or

c) thermal smoke removal systems

in accordance with DIN 18 232-2 or VdS 2098.

(2) Protected corridors, necessary stairways and air lock annexes shall stay free of smoke even in the case of a mechanical smoke removal from other regions.

9 Cable Ducts, Cable Support Structures including Mounting Elements in the Vicinity of Cable Fire Shields

(1) Cable fire shields shall be designed as specified under Section 6.3.3.

Note:
Regarding the earthquake design of cable trays, cf. KTA 2201.4.

(2) The cable support structures of cable ducts in the course of which fire resistant cable fire shields are required and their connecting and mounting elements shall be designed such that in the event of fire the room isolation by the cable bushing remains intact.

10 Tests and Inspections

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

Appendix A

Simplified Validation Procedure for Determining the Required Fire Resistance Rating of Structure-related Fire Protection Measures

A 1 Basis Data of the Validation Procedure

The simplified validation procedure described in the following may be used in determining the fire resistance rating of structure-related fire protection measures (also refer to [1]).

Basis data of the validation procedure are lists identifying the rooms with their geometry, the masses and calorific values of the contained combustible materials as well as the ventilation conditions due to openings that, in the event of fire, are regularly or irregularly in the open position or, due to forced ventilation, have a specified volume flow rate.

Specifically, the following data are required:

a) room area, A, in m^2,

b) room height, H, in meters,

c) sum of natural ventilation openings, A_V, in m^2,

d) forced ventilation air flow rate, $\dot{V}_{zu}$ in m^3/h,

e) masses, M_i, of unprotected combustible materials (e.g., oil, cables), in kg, as well as their calorific values, H_{ui}, in kWh/kg,

f) masses, M_j, of combustible materials protected against ignition by enclosure in containments, closed systems or other enclosures (e.g., intumescent coating in the case of cables), in kg.

The criterion for the expected fire loading of structural elements in the natural course of a fire event is the equivalent fire duration, t_a, in accordance with DIN 18 230-1; this is determined in dependence of a theoretical fire load density, q_R.

A 2 Theoretical Fire Load Density, q_R

The theoretical fire load density, q_R in kWh/m^2, is calculated from the individual masses, M_i, the calorific value, H_{ui}, and the combustion efficiencies of the unprotected combustible materials, X_i, as well as from the corresponding values M_j, H_{uj} and X_j of the protected combustible materials and, if applicable, under consideration of the energy losses, ΔQ_W, due to heat sinks.

$$q_R = (Q_u + Q_g - \Delta Q_W) / A \qquad \text{(A 2-1)}$$

where

Q_u : sum of unprotected fire loads – in kWh

$$Q_u = \Sigma (M_i \cdot Hu_i \cdot X_i) \qquad \text{(A 2-2)}$$

Q_g : sum of protected fire loads – in kWh

$$Q_g = \Sigma (M_j \cdot Hu_j \cdot X_j \cdot \psi_j) \qquad \text{(A 2-3)}$$

ΔQ_W : sum of energy losses due to heat sinks – in kWh as specified under Section A 4

The calorific values, H_{ui}, and combustion efficiencies, X_i, for some common combustible materials are listed in **Table A 2-1.**

In the case of mixed fire loads – and lacking exact values – the maximum value of the individual combustion efficiencies, max X_i, shall be assumed for all combustible materials involved (e.g., X = 1.0 for the overall fire loading in the case of a fire involving oil and cables).

Note:
Exact values for mixed fire loads are not available at this time; they can only be determined from experiments.

No.	Type of Material [1]	Material-related Values		
		H_u		X
		MJ/kg	kWh/kg	–
1	Oil	42.0	11.7	1.0
2	PVC-cable	18.0	5.0	0.5 [2]
3	Wooden cribs	17.3	4.8	0.75 [2]
4	Activated carbon (charcoal)	32.8	9.1	1.0 [4]
5	Hydraulic oil, DTE	40.5	11.3	0.8 [2]
6	Polypropylene	43.9	12.2	0.9 [3]
7	Paper	13.7	3.8	0.75 [3]
8	Cotton rags	31.7	8.8	0.75 [3]
9	Polyethylene (granulate)	43.2	12.0	0.8 [2]
10	Polyethylene with 25% chlorine	31.6	8.8	0.7 [3]
11	rubber (caoutchouc)	42.1	11.7	1.0 [4]
12	Cold cleaning fluid (gasoline)	42.8	11.9	1.0
13	Lubrication grease	41.4	11.5	1.0 [4]
14	Glycol	16.6	4.6	0.8 [2]
15	Polystyrene	39.2	10.9	0.65 [3]
16	Methanol	20.0	5.6	0.95 [3]
17	Heptane	44.6	12.4	0.95 [3]

1) Further material types are presented in [2]

2) Experimentally determined values from [3] with a 0.1% variance

3) Values from literature (cf. [3])

4) These are conservative estimations. Exact values are not available at this time and can only be determined experimentally.

Table A 2-1: Important material-related values of fire loads

The combustible materials that are protected by containing them in closed systems or other containments can be reduced by applying combination coefficients, ψ_j. The following values may be assumed without detailed validation:

$\psi_j = 0.8$ for the largest individual protected fire load (A 2-4)

$\psi_j = 0.55$ for other protected fire loads (A 2-5)

The consideration of energy losses due to heat sinks is an iterative procedure. Initially it is assumed that $\Delta Q_W = 0$; the further procedure is presented in Section A 4.

A 3 Equivalent Fire Duration, t_a

Under consideration of the actual height, H, and ventilation conditions inside the fire room, the equivalent fire duration, t_a in min, is determined in dependence of the theoretical fire load density, q_R, from equations (A 2-1) through (A 2-3) as follows:

$$t_a = t_{a,0} \cdot f_H \cdot f_{Av} \qquad \text{(A 3-1)}$$

where

$t_{a,0}$: basic value of the equivalent fire duration (in min) for the most unfavorable ventilation and for a room height H_{ref} = 2.5 meters

f_H : correction factor for other room heights, H

f_{Av} : correction factor for the actual ventilation conditions

The basic value $t_{a,0}$ can be readout from the value diagrams of **Figure A 3-1** or **Figure A 3-2** (identical in content, shown in different plotting scales).

The value diagrams of **Figure A 3-1** and **Figure A 3-2** differentiate between the following cases:

a) uniformly distributed fire load: fire extends over the entire room,

b) non-uniformly distributed fire load: fire is limited to a larger partial area of the room,

c) point-source fire load: entire fire load is afire in a small localized area.

The correction factor, f_H, for a room height different from the reference room height, H_{ref}, shall be calculated using equation (A 3-2):

$$f_H = \left[\frac{H_{ref}}{H}\right]^{0,3} \qquad \text{(A 3-2)}$$

The correction factor, f_{Av}, for the actual ventilation condition can be readout from **Figure A 3-3** in dependence of the relative effective overall opening surface, $A_{V,eff}/A$:

$$f_{AV} = f(A_{V,eff} / A) \qquad \text{(A 3-3)}$$

where

$$A_{V,eff} = A_V + \dot{V}_{zu} / 6000 \text{ – in } m^2 \qquad \text{(A 3-4)}$$

A_V : overall surface area of vertical openings in the enclosing walls – in m^2

$\dot{V}_{zu}$: volumetric air supply rate in the case of forced ventilation – in m^3/h

A 4 Consideration of Heat Sinks

The influence on the expected fire effect of energy losses to available heat sinks inside the fire room, e.g., to

a) structural concrete elements such as partition walls, support columns (Q_B),

b) structural steel elements such as bearing and support structures (Q_S),

c) high-volume vessels for liquids (Q_F),

may be taken into consideration by the overall energy loss, ΔQ_W, in equation (A 2-1). Herein

$$\Delta Q_W = \Sigma Q_{W,i} \qquad \text{(A 4-1)}$$

where

$Q_{W,i}$ = Q_B, Q_S or Q_F – in kWh

The energy losses $Q_{W,i}$ may, generally, be determined as follows:

$$Q_{W,i} = M_W \cdot c_{p,W} \cdot (\overline{T}_{SW} - T_0) \cdot 1/(3.6 \cdot 10^6) \qquad \text{(A 4-2)}$$

where

M_W : mass of the component – in kg

$c_{p,W}$: specific thermal capacity of the component – in J/(kg K)

$\overline{T}_{SW}$: calorific mean temperature of the component – in °C

T_0 : operating temperature of the component – in °C

The calorific mean temperature, $\overline{T}_{SW}$, can be readout from **Figure A 4-1** in dependence of the previously calculated equivalent fire duration, t_a, and the group parameter, σ_W in $10^{-6}\ s^{-1}$,

$$\sigma_W = \left(\frac{\alpha_W}{\rho_W \cdot c_{p,W}}\right) \cdot \left(\frac{A_W}{V_W}\right) \qquad \text{(A 4-3)}$$

where

A_W : fire affected surface area of the component – in m^2

V_W : volume of the component – in m^3

A_W/V_W : profile factor – in m^{-1} (analogous to U/A in accordance with Sec. 6.1.2 DIN 4102-4)

α_W : heat transfer coefficient – in $W/(m^2 \cdot K)$

ρ_W : density of the component – in kg/m^3

$c_{p,W}$: specific thermal capacity – in J/(kg K)

The thermal characteristics of the materials in question can be readout from **Table A 4-1.**

Material	α_W $W/(m^2 \cdot K)$	ρ_W kg/m^3	c J/(kg K)
Concrete	20	2200	879
Steel	20	7850	600
Water	–	1000	4182
Oil	–	910	1880

Table A 4-1: Thermal characteristics of different materials

Instead of reading out the calorific mean temperature $\overline{T}_{SW}$ from **Table A 4-1**, it may be determined from equation (A 4-4)

$$\overline{T}_{SW} = T_g[1 - \exp(-s_w \times 60 \times t_a)] \qquad \text{(A 4-4)}$$

where

σ_W : group parameter calculated from equation (A 4-5) in $10^{-6}\ s^{-1}$

t_a : equivalent fire duration – in min, determined, as a first step, without ΔQ_W

T_g : hot-gas temperature of the regular fire – in °C after the fire duration of t_a

$$T_g = 20 + 345 \cdot \log(8 \cdot t_a + 1) \qquad \text{(A 4-5)}$$

The calculation of the energy losses, Q_F, to vessels filled with fluids is based on weighted mean values of density, $\overline{\rho}_F$, and the specific thermal capacity $\overline{c}_{p,F}$:

$$\bar{\rho}_F = \mu_{BE} \cdot \rho_{BE} + \mu_{FL} \cdot \rho_{FL} \quad \text{(A 4-6)}$$

$$\bar{c}_{pF} = \mu_{BE} \cdot c_{p,BE} + \mu_{FL} \cdot c_{p,FL} \quad \text{(A 4-7)}$$

where

$c_{p,BE}$: specific thermal capacity of the vessel wall – in J/(kg K)

$c_{p,FL}$: specific thermal capacity of the fluid – in J/(kg K)

ρ_{BE} : density of the vessel wall – in kg/m³

ρ_{FL} : density of the contained liquid – in kg/m³

$$\mu_{BE} = \frac{M_{BE}}{M_{ges}}; \quad \mu_{FL} = \frac{M_{FL}}{M_{ges}} \quad \text{(A 4-8)}$$

$$M_{BE} = A_F \cdot d_{BE} \cdot \rho_{BE} \quad \text{(A 4-9)}$$

$$M_{FL} = V_F \cdot \rho_{FL} \cdot h/100 \quad \text{(A 4-10)}$$

$$M_{ges} = M_{BE} + M_{FL} \quad \text{(A 4-11)}$$

where

A_F : surface area of the vessel – in m²

d_{BE} : thickness of the vessel wall – in meters

V_F : volume of the vessel – in m³

h : average filling of the vessel – in %

A 5 Required Fire Resistance Rating, erf t_f

The required fire resistance rating, erf t_f in min, of the structure-related fire protection measures results from the multiplication of the equivalent fire duration, t_a, with a safety factor, γ:

$$\text{erf } t_f = \gamma \cdot t_a \quad \text{(A 5-1)}$$

The safety factor, γ, shall be readout from **Table A 5-1** under consideration of the importance of the components in question, of the intended fire protection measures and the basic ventilation conditions.

Fire Fighting Category	Ventilation	Safety Factor, γ, for Fire Safety Class		
		SK_b 3	SK_b 2	SK_b 1
A	p	1.45	1.10	0.7
	u	0.85	0.50	0.5
B	p	1.35	1.00	0.6
	u	0.80	0.50	0.5
C	p	1.10	1.00	0.5
	u	0.50	0.50	0.5
D	p	0.75	0.50	0.5
	u	0.50	0.50	0.5
p : planned u : unplanned				

Table A 5-1: Safety factor, γ, for the design of structure-related fire protection measures in nuclear power plants

Regarding fire fighting effectivity, the following four categories are considered:

a) Category A: manual fire fighting after on-site clarification of the situation; action begins more than10 min after occurrence of the fire.

b) Category B: manual fire fighting by on-site personnel; action begins less than10 min after occurrence of the fire.

c) Category C: stationary fire extinguishing systems triggered manually; action begins less than10 min after occurrence of the fire.

d) Category D: stationary fire extinguishing systems triggered automatically or manually on site or in the control room immediately after the fire alarm; action begins less than 2 min after outbreak of the fire.

With respect to ventilation, it is differentiated between planned (p) and unplanned (u) ventilation conditions. In the case of planned ventilation consideration is taken of

a) all openings (including doors) that stand open in the event of fire,

b) the leakage openings in the enclosing structural elements and

c) the available forced ventilation that would continue to be in operation in the event of fire.

In the case of unplanned ventilation, consideration is taken of

a) doors standing open that, regularly, would be closed in the event of fire, e.g., due to the failure of a certified close-and-retain system or

b) continued operation of forced ventilation that, regularly would be shut down as well as, additionally,

c) the leakage openings related to the planned ventilation.

Note:
In the case of planned ventilation,

a) the mentioned openings also comprise those that would have a high probability to stand open in the event of fire, e.g., blockage of the fire protection doors.

b) the mentioned available forced ventilation also comprises such ventilation the shutdown or locking of which is not specified unambiguously, e.g., in the fire protection regulation of the operating manual.

Regarding the design of structural elements, they shall be correlated to one of the following three fire safety classes, SK_b 1 through SK_b 3:

a) SK_b 1: subordinate structural elements with fire resistance requirements, e.g., parts of the secondary support structures,

b) SK_b 2: the closures of openings or the bushings of line penetrations through partitioning structural elements,

c) SK_b 3: the structural elements that are partitions of fire compartments or fire sub-compartments or that support the partitioning elements as well as all building elements of the major support structure.

Note:
The correlation to fire safety classes occurs in accordance with DIN 18 230-1; additional details are contained in that standard. Especially in already existing power plants, a downgrading by one fire safety class is permissible, provided, the required safety level is ensured by other means (e.g., additional organizational fire protection measures).

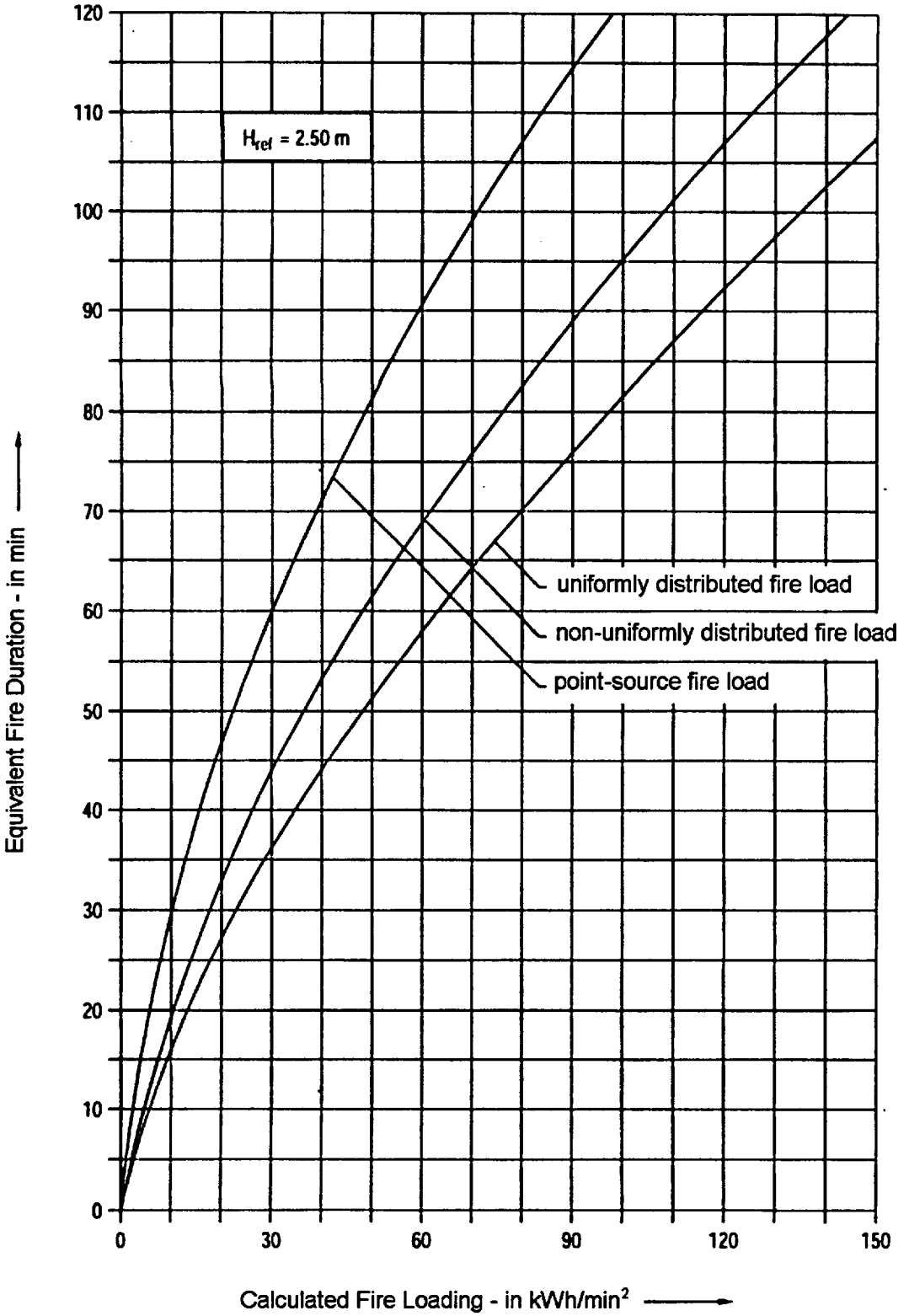


Figure A 3-1: Basic equivalent fire duration, $t_{a,0}$, as a function of the theoretical fire load density, q_R

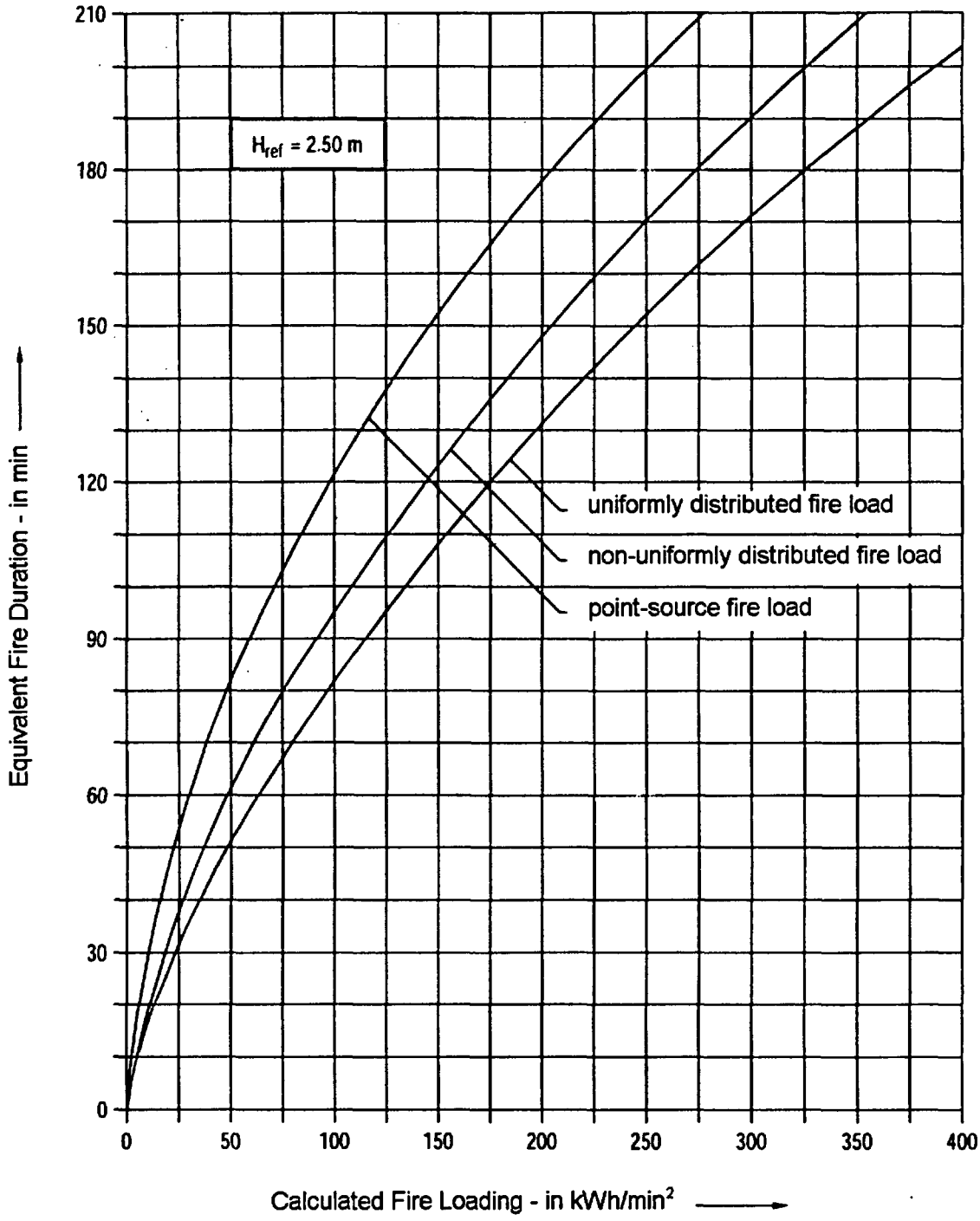


Figure A 3-2: Basic equivalent fire duration, $t_{a,0}$, as a function of the theoretical fire load density, q_R

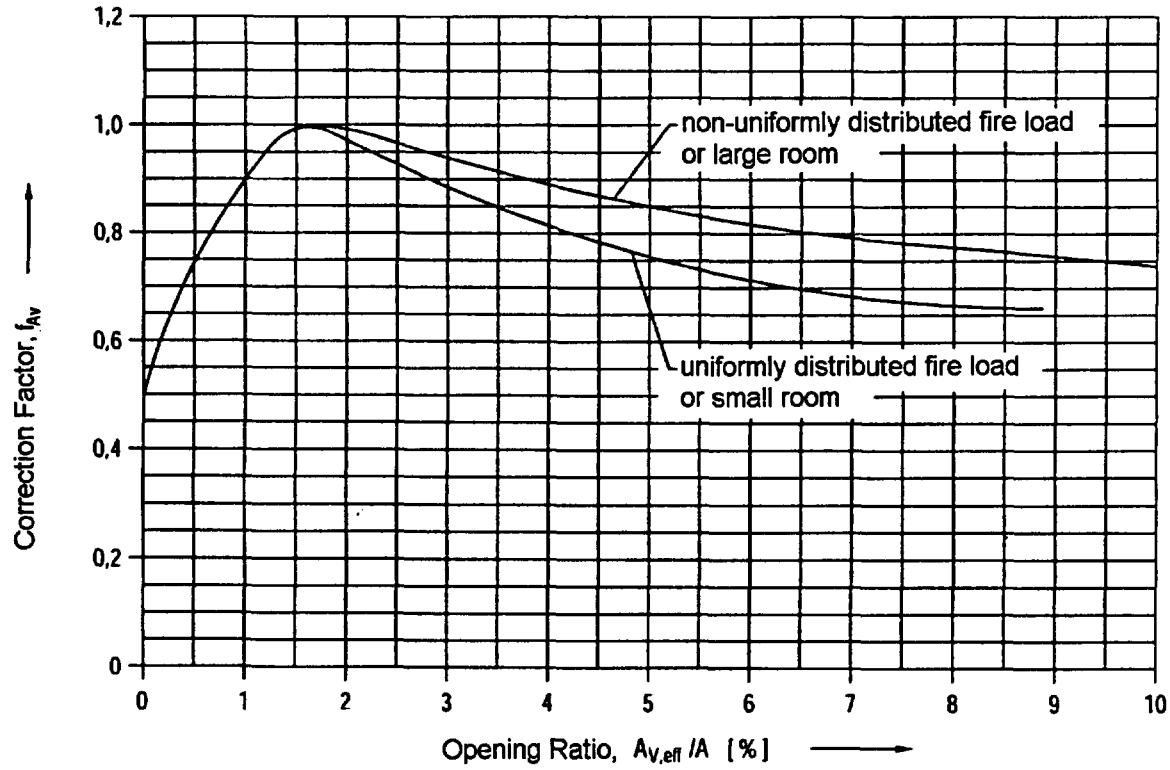


Figure A 3-3: Correction factor, f_{Av}, as a function of the opening ratio, $A_{V,eff}/A$

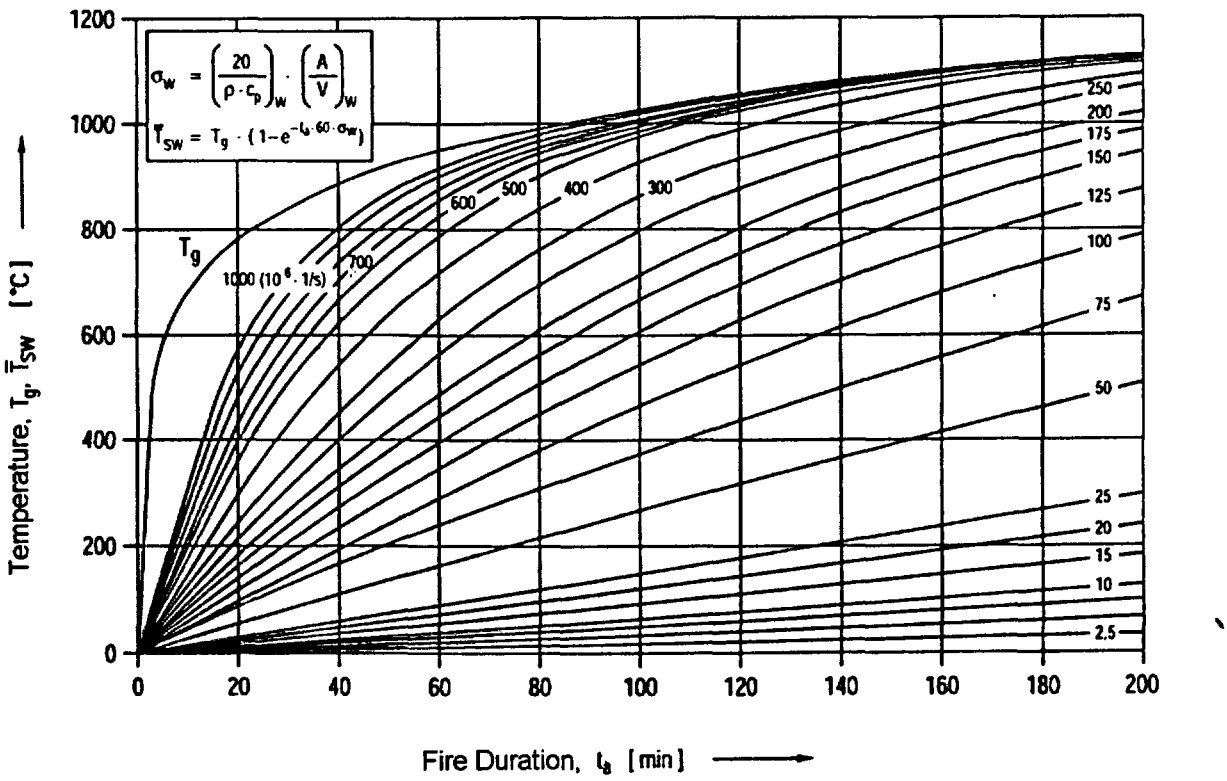


Figure A 4-1: Calorific mean temperature, $\bar{T}_{sw}$ as a function of fire duration, t_a and group parameter σ_w

Appendix B

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.

KTA 2101.1	(12/00)	Fire protection in nuclear power plants; Part 1: Basic 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 3402	(11/76)	Air locks through the containment vessel of nuclear power plants – Personnel locks
KTA 3403	(10/80)	Cable penetrations through the reactor containment vessel
KTA 3601	(06/90)	Ventilation and air filtration systems in nuclear power plants
KTA 3904	(09/88)	Control room, emergency control room and local control stations in nuclear power plants
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)	Corrigenda to DIN 4102-1:1998-05
DIN 4102-2	(09/77)	Fire behaviour of building materials and building components; Building components; definitions, requirements and tests
DIN 4102-3	(09/77)	Fire behaviour of building materials and building components; Fire walls and non-load-bearing external walls; Definitions, requirements and tests
DIN 4102-4	(03/94)	Fire behaviour of building materials and building components; synopsis and application of classified building materials, components and special components
DIN 4102-6	(09/77)	Fire behaviour of building materials and building components; Ventilation ducts; Definitions, requirements and tests
DIN 4102-7	(07/98)	Fire behaviour of building materials and building components - Part 7: Roofing; definitions, requirements and testing
DIN 4102-9	(05/90)	Fire behaviour of building materials and elements; Seals for cable penetrations; Concepts, requirements and testing
DIN 4102-11	(12/85)	Fire behaviour of building materials and building components; Pipe encasements, pipe bushings, service shafts and ducts, and barriers across inspection openings; Terminology, requirements and testing
DIN 14 090	(06/77)	Areas for the fire brigade on premises
DIN 18 095-1	(10/88)	Smoke control doors; Concepts and requirements
DIN 18 164-1	(08/92)	Rigid cellular plastics insulating building materials; Thermal insulating materials
DIN 18 164-2	(03/91)	Rigid Cellular plastics insulating building materials; Polystyrene foam impact sound insulating materials
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 52 460	(05/91)	Sealing and glazing; Terms
DIN VDE 0101	(05/89)	Erection of power installations with rated voltages exceeding 1 kV
VdS 2098	(05/90)	Heat and smoke removal systems; Guidelines for design and installation

Literature

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Untersuchungen zur Regelfähigkeit von brandschutztechnischen Nachweisen im Rahmen von KTA 2101.2 (Abschlußbericht). Schriftenreihe Reaktorsicherheit und Strahlenschutz, BMU-1996-467, im Auftrag des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit, Februar 1996, ISSN 0724-3316
Examining the possibilities for establishing standards regarding the verification of fire protection measures within the framework of KTA 2101.2 (Final Report)

[2] Schneider, U.
Festlegung von Brandszenarien für den Entwurf von Gebäuden und für die Risikobetrachtung. VdS-Fachtagung „Ingenieurmäßige Verfahren im Brandschutz" am 25. und 26. April 1995 in Köln.
Specification of fire scenarios for the design of buildings and for the risk assessments

[3] Hosser, D.; Blume, G.; Siegfried, W.; Will, J.
Untersuchungen zur Regelfähigkeit von brandschutztechnischen Nachweisen im Rahmen von KTA 2101.2 - Ermittlung effektiver Heizwerte; Untersuchung im Auftrag des BMU, Aktenzeichen SR 2226-81225-UA-1457
Examining the possibilities for establishing standards regarding the verification of fire protection measures within the framework of KTA 2101.2 – Determining actual calorific values

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 .

Note:
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

Note:
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 muffiers 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 [6]	–
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