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Nuclear Safety Standards Commission (KTA)

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KTA 1301.1

Radiation Protection Considerations for Plant Personnel in the Design and Operation of Nuclear Power Plants

Part 1: Design

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Comment:

In these English translations of KTA-Safety Standards the words shall, should and may are used with the following meanings:

- shall** indicates a mandatory requirement,
- should** indicates a requirement¹ to which exceptions are allowed. However, the exceptions shall be substantiated during the licensing procedure,
- may** indicates a permission and is, thus, neither a requirement (with or without exceptions) nor a recommendation: recommendations are worded as such, e.g., "it is recommended that".

The word combinations basically shall/shall basically are used in the case of mandatory requirements to which specific exceptions (and only those!) are permitted. These exceptions - other than in the case of should - are specified in the text of the safety standard.

¹ Please note that in the case of IAEA NUSS standards and ANSI standards, the word "should" indicates a mere recommendation.

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in the Design and Operation of Nuclear Power Plants****Part 1: Design****Table of Contents**

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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 No. 44a on March 4, 1988. Copies may be ordered through the Carl Heymanns Verlag KG, Gereonstr. 18-32, D-5000 Köln 1.

Nuclear Safety Standards Commission (KTA)

Federal Republic of Germany

Basic Principles

(1) The safety standards of the Nuclear Safety Standards Commission (KTA) have the task of specifying 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 No. 3 Atomic Energy Act; this is especially to attain the protective goals specified by the Atomic Energy Act and the Radiological Protection Ordinance (StrlSchV)).

(2) Relevant acts, ordinances and rules of the federal and state authorities as well as subordinate specifications by the authorities e.g. the Safety Criteria for Nuclear Power Plants (approved by the States Committee for Nuclear Energy) or the Guidelines of the Reactor Safety Commission, are considered in developing KTA safety standards.

(3) With regard to the protection against radiation exposure of the persons working in nuclear power plants, the aim of this safety standard is to ensure that the design of the plant is such that the protection provisions of the Radiological Protection Ordinance can be complied with - especially the basic principles of radiological protection in accordance with Sec. 28 StrlSchV and the regulations regarding occupational radiation exposure contained in Part 3, Chapter 3 StrlSchV.

(4) When planning a nuclear power plant radiological protection is one of several important considerations (others are, e.g., safety engineering, work protection, fire protection). Consequently in as far as this safety standard can only make recommendations, the purpose of these is to point out to the designers and constructors those aspects which are important from the point of view of radiological protection and shall be taken into account during construction.

(5) Safety Standard KTA 1301 consists of
Part 1: Design (Safety Standard 11/84)
Part 2: Operation (Safety Standard 6/82)

The present Part 1 has been coordinated with Sec. 4 of the Guideline for the Protection against Radiation of Personnel during the Execution of Maintenance Work in Nuclear Power Stations with Light Water Reactors; the Precautionary Measures to be taken during the Planning of the Plant, dated July 1 1978 (GMBI. 1978, p. 418).

1 Scope

(1) This safety standard applies to the planning of buildings, systems and components within the permanent controlled-access area and that part of the sanitary tract in nuclear power plants which is located outside that area.

(2) The requirements apply to both specified normal operation (Sections 3 through 8) and incidents (Section 9).

2 Definitions

(1) Sanitary Tract

The sanitary tract in a nuclear power plant consists of all the entry and exit tracts to and from the permanent controlled-access area which contain the necessary monitoring equipment together with personnel cleansing facilities and the area where working and protective clothing is issued.

The part of the sanitary tract within the controlled-access area includes changing rooms, the clothing issue area and showers and washrooms for persons leaving the controlled-access area.

The part of the sanitary tract outside the controlled-access area (monitored area) includes changing rooms, washrooms, showers and lavatories.

(2) Assembly Opening

An assembly opening is an opening; (e.g. hatch, concrete block wall, door) required for the assembly and disassembly of components.

3 Rooms of the Controlled-Access Area

Note:

The controlled-access area in a nuclear power plant is an area with controlled access which includes all those areas in which, in accordance with the definition in the Radiological Protection Ordinance, 15 mSv/a (1.5 rem/a) might be exceeded at certain specific locations.

3.1 General Requirements

3.1.1 Room Classification

When planning the rooms, these shall be classified in accordance with DIN 25440.

3.1.2 Room Arrangement

(1) Access to each room should be possible via traffic routes (e.g. passageways).

(2) Basically, rooms which cannot be reached via traffic routes shall be arranged in such a way that access to them is only possible via rooms which are not of a higher class than themselves. Exceptions are permitted if no appreciable radiation exposure is to be expected from passing through.

Note:

Specifications regarding the transportation of radioactive objects within nuclear power plants are laid down in KTA 3604, and specifications regarding rescue routes in KTA 2102 (in preparation).

3.1.3 Room Design

3.1.3.1 Access Openings

(1) Access openings to rooms e.g. doors, escape openings, ceiling and floor hatches, pressure hatches) shall basically be designed in such a way that they do not determine the room class of the preceding room from which they have access. Exceptions are permitted where the main purpose of the preceding room is mainly to provide access.

Note:

Possible measures are, for example:

- suitable arrangement in relation to the radioactive components,
- labyrinths (radiation traps),
- shield doors,
- shield walls.

(2) Furthermore, access openings should be arranged such that the work locations in the room can be reached via areas where local dose rates are as low as possible.

(3) Moreover, access openings shall be made large enough to permit the entry of the auxiliary equipment which is already known to be necessary at the planning stage (e.g. compressed-air respirators, tools, transportation facilities) and of the parts which will probably need replacing due to wear and tear (see Table 3-1).

(4) Access openings shall not be walled up. The closing of access openings with mountable walls (e.g. of concrete blocks or slabs) is only permitted in those rooms which are not expected to be entered more than once a year.

	Clear width	Clear height
Doors	in accordance with ASR 10/1 *)	
Escape holes	0.60 m	1.40 m
Ceiling or floor hatches	0.70 m (0.80 m **)	0.60 m
Pressure hatches	0.57 m (Lower edge 0.25 m above ground)	1.40 m
*) The hazard level classification in accordance with Sec. 2 ASR 10/1 shall be specified in each individual case.		
**) Minimum measurements for the use of self-contained respirators if it is not possible to supply air via flexible tubes for reasons of e.g. length.		

Table 3-1: Minimum Measurements for Access Openings

3.1.3.2 Assembly Openings

The arrangement and design of assembly openings shall permit the disassembly and assembly of radioactive components taking into account the necessary assembly equipment and shieldings (also see section 4.1.2(2)) and a transportation route that is favorable in terms of radiological protection. They should be designed such that their contribution to the local dose rate of a room does not determine the room class.

3.1.3.3 Wall Penetrations

Wall penetrations should be designed such that their contribution to the local dose rate of a room does not determine the room class.

Note:

Possible measures are, for example:

- a) slits and wall penetrations at an inclined angle;
- b) covers or lead-wool packings for wall penetrations;
- c) arrangement outside the generally accessible area (e.g. under the ceiling).

3.1.3.4 Walls, Shielding

(1) With respect to their shielding effect, the walls of a room containing radiation sources shall be designed such that the share of the local dose rate in this room that is caused by incident radiation from adjacent rooms does not exceed 20% of the upper room class limit.

(2) The following locations shall be shielded such that the local dose rate does not exceed 5 $\mu\text{Sv/h}$ (0.5 mrem/h):

- a) workplaces which are expected to be occupied for more than 1,000 hours per year (e.g. the control station or the liquid waste treatment system);
- b) the sanitary tract (see Section 3.2);
- c) the first-aid station (see Section 3.3).

(3) Certain parts of frequently used traffic routes (e.g. main passageway in the reactor auxiliary building) be shielded such that in the generally accessible area of the respective room the local dose rate does not exceed 10 $\mu\text{Sv/h}$ (1 mrem/h) up to a height of 2 m above the accessible levels.

3.1.3.5 Load-Bearing Capacity of Floors

(1) When designing traffic routes with regard to their load-bearing capacity expected transportation facilities shall be taken into account, including the loads anticipated during both assembly and operation, together with any necessary shielding.

(2) If a local dose rate of more than 1 mSv/h (100 mrem/h) is anticipated at a distance of 0.5 m from a component, the load-bearing capacity of the floors and platforms shall basically be designed such that any necessary additional shielding can be installed. For this purpose, a line load of 10 kN/m over a maximum length of 3 m at the most unfavorable point shall be assumed.

(3) A load-bearing capacity in accordance with paragraph 2 may be disregarded if

- a) shielding is ensured by adequate separation of the components,
 - b) the installation of additional shielding leads to a greater collective dose than is avoided by the installation,
- or
- c) additional shielding would unduly obstruct the work to be done there.

(4) Basically, additional shielding need not be taken into account when designing floors and platforms against dynamic loads. Not included here is such shielding as is installed on a long-term basis where a failure of the floors or platforms,

- a) during power operation, could cause damage to safety-related components, or
- b) in the case of work done during a planned shutdown, could damage a further necessary redundancy in addition to the one on which work is being done.

(5) The floors of radioactive waste stores which are not filled by remote control, as well as the floors of the hot workshop, the decontamination room and the stowage room for parts and components, shall be designed for a line load of 10 kN/m over a maximum length of 5 m (see KTA 3604).

(6) The load-bearing capacity of floors and platforms shall be indicated at the actual location (also see Sec. 8 para. 2 ArbStättV).

3.1.3.6 Room Dimensioning

(1) Rooms should be designed such as to permit the rapid execution of maintenance work. Consideration shall be given hereby to the shieldings of components as well as to any necessary additional shielding (also see Sections 4.1.1 and 7) and other required pre-requisites for the work to be done (e.g. full protective clothing).

(2) It shall be ensured that sufficient space is available near the disassembly area to set down components and parts which are temporarily removed and for any radiological protection measures required in connection with such removal (also see Section 4.1.1 (5)).

(3) A stowage room for the interim storage of disassembled radioactive components and parts, or equivalent set-down areas which meet the same requirements, shall be provided for in accordance with Sec. 6.1 KTA 3604.

3.1.4 Room Fixtures and Fittings

3.1.4.1 Surfaces

(1) The walls, ceilings and floors of rooms in the containment vessel shall have surfaces which are easy to decontaminate. Rooms within the controlled-access area but outside the containment vessel, where there are pressurized systems carrying radioactive liquids, shall be treated similarly. In rooms within the controlled-access area but outside the containment vessel, where unsealed radioactive substances are expected to be handled, an easily decontaminable surface up to a height of 2 m is sufficient.

- (2) The floor of the sanitary tract, both inside and outside the controlled- access area, shall be easily decontaminable.
- (3) Especially in the case of the floors of traffic routes, the surface coatings shall be jointless, waterproof, sufficiently resistant to pressure and hard wearing.

3.1.4.2 Room Drainage

(1) In the rooms where components carrying radioactive water are installed, room drainage systems feeding into the building drainage tank (building sump) should basically be available. Adequate floor gradients shall ensure that any water released is conducted directly into the room drainage system.

(2) A room drainage system from vessel rooms is not necessary if the whole room is constructed as a waterproof trough which can hold the contents of the largest vessel in the room in as far as a failure of this vessel is required to be assumed. In such a case, adjacent vessel rooms may be constructed as a single trough. It shall be possible to conduct any water from the trough into tanks (e.g. by means of mobile submersible pumps or permanently laid pipes to a hold-up tank).

3.1.4.3 Fixtures

- (1) The rooms shall be equipped with the required number of power, compressed-air and water supply points.
- (2) Lighting fixtures in the rooms shall require little servicing and be fitted with easily replaceable lamps or bulbs.
- (3) In the case of components which are expected to require maintenance but where no permanently installed lifting equipment is planned, provision shall be made for temporary auxiliary disassembly equipment. This is not necessary if the conditions specified in **Table 3-2** are fulfilled.

Mass of the Component or Part	Boundary Condition for Handling
up to 15 kg	none
up to 25 kg	easily accessible for one person and assembly location not above chest height
up to 50 kg	easily accessible for two persons and assembly Location not above chest height
up to 100 kg	horizontal transportation by two persons

Table 3-2: Handling without auxiliary equipment

3.2 Sanitary Tract

(1) The sanitary tract shall be shielded such that the local dose rate does not exceed 5 µSv/h (0.5 mrem/h).

Note:
A lower local dose rate may be required for exit contamination monitors and dose meters in certain locations.

(2) The sanitary tract shall be designed such that there is sufficient space for the plant personnel, outside personnel and visitors to change and wash and such that there are a sufficient number of monitors available.

(3) The reference value with respect to plant personnel when planning the sanitary tract is 120 persons; at least three times that number outside personnel shall be assumed.

Note:
The necessary sanitary equipment is located partly inside but mainly outside the controlled-access area and complies in its entirety with the Workplace Ordinance.

(4) A contamination checkpoint shall be provided for small items (e.g. tools) which are brought out of the controlled-access area. It is recommended to provide equipment near the contamination checkpoint for any decontamination of these items which may prove necessary.

(5) To reduce the danger of spreading contamination, the part of the sanitary tract within the controlled-access area adjacent to the entry and exit monitoring positions shall be designed such that persons entering and exiting can be conducted separately.

(6) Space shall be provided for preliminary checks of persons wanting to leave the controlled-access area to determine whether decontamination measures are required.

3.3 First-Aid Station

(1) A special room shall be set up within the controlled-access area for first-aid purposes and preliminary medical treatment of injuries. This room shall be set up in an easy-to-reach position in an area where there is little danger of contamination. With regard to the contamination measurements which may be necessary, the local dose rate in the first-aid station should not exceed 5 µSv/h (0.5 mrem/h). Care shall be taken to ensure that injured persons can be transported easily and gently.

(2) The first-aid station shall be easy to reach with a stretcher. It shall be provided with all the necessary facilities and equipment required for fist-aid purposes and preliminary medical treatment and shall be designed accordingly (Sec. 38 para. 2 ArbStättV).

- Notes:**
- 1) A room with an area of 4 x 5 m and a clear height of 2.80 m is suitable to contain the necessary fittings and equipment.
 - 2) The equipment in the first-aid station is specified in compliance with Sec. 3 of the Work Safety Act in consultations between the authorized physician (Sec. 71 StrlSchV) and the licensee.
 - 3) A first-aid room which fully complies with Workplace Guideline ASR 38/2 is located outside the controlled-access area.
 - 4) With regard to the accessibility of the first-aid station, specifications will have to be drawn up in conjunction with the rescue routes in KTA 2102 (in preparation).

(3) Equipment shall be provided for the easy decontamination of the injured. This equipment may also be accommodated outside the first-aid station.

3.4 Space Requirements for Health Physics

The following space requirements shall be taken into account during the planning phase for health physics:

- a) rooms for the preparation, carrying out and analysis of measurements,
- b) space for the calibration of mobile radiation monitoring instruments,
- c) space for auxiliary health physics material,
- d) space for radioactive samples and calibration isotopes.

Notes on a) and b):
The shielding of these rooms is often determined by the necessary measurements to be taken.

3.5 Space Requirements for the Processing and Storage of Contaminated Parts

3.5.1 Decontamination Rooms

The necessary rooms and locations shall be provided for the decontamination of disassembled parts and components as well as that of mobile equipment (see Sec. 6.2 KTA 3604).

3.5.2 Hot Workshop

A workshop shall be set up inside the controlled-access area for the processing of radioactive parts and components (Hot Workshop, see Sec. 6.3 KTA 3604).

3.5.3 Storage Facilities

A storage facility shall be set up for contaminated parts which have been prepared for re-use and for contaminated tools (see Sec. 6.4 para. 1 KTA 3604).

4 Components

4.1 General Requirements

4.1.1 Component Arrangement

(1) In view of the radiation exposure during maintenance, highly radioactive components with the exception of valves and pipes should be installed in their own separate rooms. If other important aspects hinder this approach (e.g. structural or process engineering reasons), other measures (e.g. distance, operating aids, shielding) to reduce radiation exposure shall be considered in the planning.

(2) Components, or their parts, which are expected to require frequent maintenance work are recommended to be arranged in the room such that they can be reached without avoidable radiation exposure.

(3) Provision shall be made for the space required to carry out maintenance work on components. For this purpose, particular care shall be taken with regard to operating aids (e.g. lifting trucks or manipulators) and the necessary additional shielding.

(4) It is recommended to arrange components in such a way that work does not need to be done in a forced (e.g. lying down) position (also see Section 7).

(5) It shall be ensured that sufficient space is available near the components to set down and provide interim storage for the parts disassembled during maintenance work (also see Section 3.1.3.6 (2)).

(6) It is recommended to arrange components such that any necessary mobile shielding can be brought in and set up with the least possible hindrance and task time. In this connection, reference shall be given to pre-assembled shielding.

(7) It is recommended to arrange auxiliary and monitoring equipment such that it is shielded from highly radioactive components.

(8) In the case of drives of highly radioactive components (e.g. agitators in concentrate storage tanks, or PWR reactor coolant pumps), it is recommended that shielding be provided between the drive and the component if there are no opposing structural or design reasons.

(9) Connecting pipes and equipment attached to pumps and tanks containing radioactive materials shall be placed such that any required maintenance work on the respective components can be done as far as possible extent without disassembling the connecting pipes and attached equipment.

4.1.2 Design of Components

(1) Components in areas of high local dose rates shall be designed to require particularly little maintenance (e.g. long life of wearing parts) and be easy to maintain.

(2) If the maintenance of components requires their periodic disassembly and re-assembly, the assembly equipment required and, if necessary, shielding transportation equipment shall be included in the planning.

(3) With respect to a low level of radiation exposure during inservice inspections the design of radioactive components shall be such that the shortest possible set-up and testing times are required.

Note:

It is assumed that when drawing up the testing schedule for inservice inspections and the testing instructions, the requirement for inservice inspections and the collective dose resulting from such inspections are carefully weighed against each other.

(4) In connection with short set-up and testing times, the points to be taken into account shall include the following:

- small number, convenient arrangement and the preparation of welds subject to inservice inspections,
- use of testing equipment which can be remotely controlled in the case of components of the reactor coolant pressure boundary in accordance with KTA 3201,
- consideration of alternative tests in accordance with Sec. 24 of the Trade and Industrial Code if these can lead to a reduction of radiation exposure while still fulfilling the purpose of the test (e.g. pressure test instead of an internal visual inspection).

(5) It should be possible to completely drain components carrying radioactive liquids. The number of drainage points shall be reduced to a minimum.

(6) It shall be possible to purge components or system sections in which significant amounts of non-adherent deposits of radioactive materials are anticipated (e.g. auxiliary equipment vessels, system sections containing concentrates or ion exchanger resins) in order to remove these materials.

(7) In areas with local dose rates higher than 100 $\mu\text{Sv/h}$ (10 mrem/h), it is recommended that controls which are operated frequently (e.g. on a regular shift basis) and process measuring instruments which are read frequently (e.g. thermometers, level and position indicators) are designed such that they can be operated or read by remote control from locations where the local dose rate is lower.

(8) Manholes in vessels and vessel-like components shall be designed in accordance with Sec. 2.3 AD Reference Sheet A5. If the work to be done requires full protective clothing provision shall be basically made for their dimensions to be larger than the minimum measurements specified in AD Reference Sheet A5. This does not apply to vessels where this is not admissible for reasons of design (e.g. steam generators).

Note:

Further requirements for vessels in connection with the storage and handling of radioactive liquid wastes are contained in Sec. 5.2 KTA 3604.

4.1.3 Choice of Materials

Note:

The choice of the materials which are in contact with the reactor coolant has a considerable influence on occupational radiation exposure (e.g. during maintenance work or waste treatment) due to the formation and deposition of activated corrosion products. In this

respect, the formation of Co-60 from Co-59 and Co-58 from Ni-58 is of particular importance.

Factors contributing to the formation of radioactive corrosion products include:

- coatings with a high cobalt content (e.g. Stellites®) which are necessary because of their resistance to abrasion,
- steam generator tubes containing nickel (in the case of pressurized water reactors),
- feedwater system components (in the case of boiling water reactors),
- austenitic surfaces of the pipes and internals of the reactor pressure vessel,
- structural parts of fuel assemblies.

The problems arising from corrosion and erosion of materials which are in contact with the reactor coolant, and the behavior of the materials thus introduced into the process circuit, do not at present permit any specifications regarding operating conditions, the nature of the materials and the deposition processes.

4.1.4 Thermal Insulation of Components

(1) Those parts of thermally insulated components of the pressure boundary of the reactor coolant in accordance with KTA 3201 on which maintenance work is planned or expected to be done, shall be provided with an insulation which is easy to remove and refit (e.g. by means of rapid fastening devices).

(2) Vessels and apparatuses which are not part of the pressure boundary of the reactor coolant in accordance with KTA 3201 shall be treated similarly if it is planned to subject them to inservice inspections and if a local dose rate in excess of 1 mSv/h (100 mrem/h) is expected at a distance of 0.5 m.

4.1.5 Component Identification

Components shall be unambiguously, durably and clearly marked to permit rapid identification. If the components have shielding or removable thermal insulation, the identification marks shall be clearly recognizable both with and without the shielding or thermal insulation.

4.2 Reactor Pressure Vessel

To open and close the reactor pressure vessel of light water reactors, devices shall be provided (stud tensioners and nut runners) which minimize the time spent in the radiation field.

4.3 Control Rod Drives

In the case of boiling water reactors, the devices securing the control rods against ejection shall be arranged such that during maintenance work on the drives these devices can either be easily removed or are not a major hindrance to the work to be done.

4.4 Steam Generators

In the case of a pressurized water reactor, each of the individual rooms of a steam generator which are accessible for inspection shall be equipped with a separate manhole accessible from outside. Handling of the manhole covers shall be facilitated by means of auxiliary equipment. Tensioners or easy to handle fasteners should be provided. In particular, it shall be ensured that the seals are easy to handle.

4.5 Pumps and Compressors

(1) Pumps - and, in the case of a high temperature reactor, compressors - shall be subject to special leak-tightness requirements in as far as they carry highly radioactive media.

(2) Pumps arranged horizontally shall be designed such that maintenance work can be done without disassembling or moving the pump drive (e.g. by means of a removable part in the drive shaft).

4.6 Valves

(1) As far as possible, heavy top parts of valves shall be arranged vertically in order to accelerate their removal and adjustment. In the case of valves installed at an angle suitable disassembly aids shall be provided.

(2) Sufficient space should be provided to set down the machines used to work on the valves (e.g. valve seat grinding machines).

(3) Safety valves should be easy to replace.

(4) Valves should be arranged such that the drive can be temporarily shielded in relation to the body of the valve.

(5) Valves acted upon by media which are highly contaminated by radioactivity shall be subject to special leak-tightness requirements.

(6) It should be possible to carry out the replacement and re-tightening of seal packings without too much effort.

4.7 Pipes

(1) It is recommended that pipes carrying radioactive materials be physically separated from pipes carrying inactive media (e.g. by being placed in ducts or by spatial separation).

(2) In order to reduce the deposition of radioactive substances, it is recommended that pipes carrying radioactive materials be designed such as to allow free flow.

(3) It is recommended that the space around pipes carrying radioactive media for which inservice inspections are planned or which are expected to require maintenance work, be designed such that the respective positions along the pipes can be approached from all directions with testing apparatuses, welding tools or the equipment required to work on the pipes.

(4) The drainage of systems carrying radioactive materials, with the exception of the residual drainage of components should be done via permanently installed closed pipes (e.g. no open funnels). Flexible connection tubes for drainage purposes and discharge systems for filling of transportation tanks may be considered as exceptions to the permanent installation requirements. The tubes used should be short. It should be possible to check the drainage procedure.

4.8 Electrical Equipment and Instrumentation and Control Equipment

(1) Electrical drives should be placed in locations with a low local dose rate. If this is not possible, they should require little maintenance and be capable of being quickly replaced or adjusted.

(2) Cables through shielding walls shall be installed such that the shielding effect of the wall in generally accessible areas is not detrimentally affected.

(3) If it is unavoidable to position electrical measuring and control equipment in areas with a high local dose rate, it is

recommended that provision be made for their quick replacement (e.g. plug-in units).

5 Ventilation Systems

Note:

Safety Standards KTA 3601 "Ventilation Systems in Nuclear Power Plants" and KTA 1502 "Monitoring Radioactivity in the Containment Atmosphere of Nuclear Power Plants" are in preparation at present.

Among other things, KTA 3601 deals with the functions of ventilation systems, their classification according to requirement levels, requirements for air filtration equipment and testing requirements.

KTA 1502 includes requirement specifications for the rooms and groups of rooms to be monitored, specifications for their monitoring with both stationary and mobile devices, for measuring procedures and for the maintenance of the devices.

Sec. 6.3.4 KTA 3604 specifies the requirements for air extraction equipment in the hot workshop.

In as far as increased contamination of the air must be expected during work tasks, particular extraction of the air at the workplace shall be given preference over the wearing of respirators.

6 Communication Equipment

Note:

Safety Standard KTA 3901 specifies the requirements for communication equipment in nuclear power plants.

(1) In areas where maintenance work is expected and local dose rates will exceed 3 mSv/h (300 mrem/h), permanently installed connections or transmission facilities (e.g. for inter-coms) should be provided.

(2) When choosing the positions for the connections, it shall be ensured that a low local dose rate, on the one hand, and adequate proximity to the workplace, on the other.

7 Ergonomics

When specifying radiological protection measures in accordance with Sections 3 through 6, ergonomic aspects shall be taken into account with regard to maintenance work which permit both a sufficiently short working time and as accurate a comprehension of the prevailing condition as possible, thus ensuring a reduction in radiation exposure.

Notes:

From the ergonomic point of view, e.g. with regard to the freedom of movement and working posture, the following principles are of importance:

- Greater forces can be applied particularly easily in a vertical downward direction.
- When a force has to be applied in an upward direction, it is recommended that the point of application of the force on the component be as far as possible either above or below shoulder level.
- When a force has to be applied horizontally, it is recommended that the point of application of the force on the component be just below shoulder level. In this case, forces acting in a forward or backward direction can be applied particularly easily from in front of the body, and forces acting to the right or the left from the side of the body.

8 Health Physics Documents

With regard to possible large-scale or difficult maintenance work in

- locations with a high local dose rate (e.g. > 3 mSv/h (> 300 mrem/h)),

and

- hard-to-reach areas within the controlled-access area,

the technical documentation papers should be supplemented, with respect to occupational radiological protection, by

- photographs, photographic reports (with reference scale),
- audiovisual recordings as assembly instructions,
- exploded view drawings,
- models.

9 Special Aspects Regarding Incidents in Light Water Reactor

Note:

Measures to be taken in the case of incidents can at present only be specified for light water reactors.

9.1 General Principles

The measures to be taken for the radiological protection of personnel in connection with the action they are required to take in order to cope with incidents are determined by the following two design basis incidents: loss of coolant in the containment vessel, and differential pressure line break in the annulus.

9.2 Loss-of-Coolant Incident in the Containment Vessel

9.2.1 General Requirements

In the case of a loss-of-coolant incident in the containment vessel, it shall be ensured that the residual heat from the reactor core and the fuel element storage pool can be removed, the necessary switching actions carried out and information obtained to determine the incident sequence. In determining activity concentrations and dose rates for a pressurized water reactor, the incident calculation bases in accordance with Sec. 4.2 of the Incident Guidelines shall be applied, with due consideration of their scope of application.

Note:

At present, guidelines for design basis incidents have only been established for nuclear power plants with pressurized water reactors.

9.2.2 Residual Heat Removal from the Reactor Core

(1) Components which are required for the long-term removal of residual heat from the reactor core shall be designed such that they can operate for at least one year without maintenance.

(2) Repair measures need not be considered if, on the basis of probabilistic analyses, it can be demonstrated that there is sufficient availability when redundancy is taken into account.

Note:

This is the case, for example, if the probability of a failure of the residual heat removal within one year is of the same order of magnitude as the non-availability of the residual heat removal at the time the incident occurs.

(3) The following conditions and reference values are applicable with regard to the repair of the residual heat removal pumps:

- Timing**
Repairs shall be scheduled at the earliest 30 days after the occurrence of the incident.
- Accessibility**
Access to the room (considering the entire route to and from the room) containing the pump to be repaired should not expose a person to direct radiation in excess of a total of 1 mSv (100 mrem). The local dose rate along the route should not exceed 10 mSv/h (1000 mrem/h).

The residual heat removal pumps shall be installed in separate rooms.

There shall be an area in the vicinity of the room in which the pump is installed where preliminary work can be done; the maximum local dose rate here should not exceed 0.3 mSv/h (30 mrem/h).

c) Necessary spare parts

It shall be ensured that the spare parts necessary for repairs can be brought in.

d) Replacement of water and drainage

It shall be possible to fill and drain or to rinse the pumps from locations with a low local dose rate (also see Section 4.1.2 (5)).

e) Work location

At the location of the pump to be repaired, the local dose rate from adjacent rooms and adjacent components should not exceed 5 mSv/h (500 mrem/h) during repairs.

(4) If instead of repair work on the residual heat removal system, on-the-spot manual switching to other systems is planned (e.g. to the cooling system of the fuel element storage pool), then through arrangement and shielding it should be ensured that the radiation exposure of a person doing the switching, including access to the location (considering the entire route to and from the location) does not exceed the reference value of 25 mSv (2.5 rem).

9.2.3 Cooling System of the Fuel Storage Pool

In as far as it cannot, in accordance with Section 9.2.2 (2), be excluded that repairs to the pumps used to cool the fuel element storage pool could become necessary, the possibility for the repair of at least one pump shall be ensured. For this purpose, the following conditions and reference values shall apply:

a) Timing

Repairs shall be scheduled at the earliest 30 days after the occurrence of the incident.

b) Accessibility

Access to the room (considering the entire route to and from the room) containing the pump to be repaired should not expose a person to direct radiation in excess of a total of 1 mSv (100 mrem). The local dose rate along the route should not exceed 10 mSv/h (1000 mrem/h).

c) Necessary spare parts

It shall be ensured that the spare parts necessary for repairs can be brought in.

d) Work location

At the location of the pump to be repaired, the local dose rate from adjacent rooms and adjacent components should not exceed 5 mSv/h (500 mrem/h) during repairs.

9.2.4 System for the Monitoring and Limitation of Hydrogen

(1) If the system for the monitoring and limitation hydrogen is located inside the containment vessel, it shall be ensured that this system can be operated without requiring maintenance on a long-term basis.

(2) If this system is located outside the containment vessel, the following precautions shall be taken:

a) Well in time before the system is put into operation the planned rooms shall be shielded with regard to the incident conditions and the activity inventory anticipated.

This shall also apply to traffic routes and rooms if it is planned to transport the systems or parts of systems into the plant and connect them only after the occurrence of an incident.

b) When the system is put into operation, the air from the rooms where the system is installed and in which leaks may occur, shall be conducted through aerosol and iodine filters.

c) It is recommended that the supply lines to the recombination system be as short as possible.

9.2.5 Switchover of Incident Filters

In the case of a manual switchover of redundant incident filters a reference value not exceeding 5 mSv (500 mrem) should be assumed for the radiation exposure of a person during the switchover procedure, including access to the location (considering the entire route to and from the location), at the time of the maximum loading of the filters.

9.2.6 Power Plant Control Room

The power plant control room shall be shielded such that it can be occupied permanently.

9.2.7 Sampling

(1) Depending on the requirements of the post-incident situation, it may be necessary to draw samples of the primary water or of the atmosphere inside the containment vessel as early as just a few hours after the occurrence of an incident.

(2) The following conditions and reference values apply to the equipment used to draw samples of water (e.g. sump water or water from the pressure suppression chamber) or air:

a) Timing

Sampling shall be scheduled at the earliest 5 hours after the occurrence of the incident.

b) Accessibility

In as far as on-the-spot access is necessary, the exposure of a person to direct radiation during access to the sampling points (considering the entire route to and from the location) should not exceed a total of 1 mSv (100 mrem). The local dose rate along the route should not exceed 10 mSv/h (1000 mrem/h).

c) Shielding

Shielding shall be installed in such a way that the radiation exposure of person during sampling does not exceed 25 mSv (2.5 rem).

d) Size of samples

Sample volumes should be in accordance with the amounts required for the measuring procedure.

Note:

Because of the relatively high activity concentration, just a few cubic centimeters of the sample medium will be sufficient.

9.2.8 Discharge Measuring Points

(1) In order to determine the discharge of radioactive materials via the vent stack, the measuring filter at the discharge measuring point shall be changed within a few hours after the occurrence of an incident.

(2) The following conditions and reference values apply to the discharge measuring point:

a) Timing

The filter-changing procedure shall be scheduled at the earliest 1 hour after the occurrence of the incident.

b) Accessibility

In as far as on-the-spot access is necessary for this purpose, the exposure of a person to direct radiation during access to the location (considering the entire route to and from the location) the discharge measuring point should not

- exceed a total of 1 mSv (100 mrem). The local dose rate along the route should not exceed 10 mSv/h (1000 mrem/h).
- c) Shielding
Shielding shall be installed in such a way that the radiation exposure of a person in connection with the changing of the measuring filter does not exceed 1 mSv (100 mrem).
- 9.3 Differential Pressure Line Break Incident outside the Containment Vessel**
- (1) In accordance with Sec. 5.3.3.3 KTA 3501, differential pressure lines of the reactor protection system which lead out of the containment vessel should have no automatic isolations. It shall therefore be possible to isolate these lines manually in the case of a break outside the containment vessel and, consequently they shall be both accessible and capable of being isolated.
- (2) A reference value of a total of 5 mSv (500 mrem) should be assumed for the exposure of a person to direct radiation during access to the valves (considering the entire route to and from the location of the valves) to be actuated, including the actuation procedure. The reference value for the local dose rate along the route should not exceed 10 mSv/h (1000 mrem/h).

Appendix A

Regulations Referred to in this Safety Standard

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

Radiological Protection Ordinance		Ordinance on the Protection Against Damage and Injuries Caused by Ionizing Radiation (Radiological Protection Ordinance - StrlSchV) dated October 13, 1976 (BGBl. I, p. 2905, BGBl. I, 1977, p. 184, p. 269), last modified by the First Ordinance on the Modification of the Radiological Protection Ordinance, dated May 22, 1981 (BGB1. I, p. 445)
Workplace Ordinance		Ordinance on Workplaces (Workplace Ordinance - ArbStättV) dated March 29, 1975 (BGB1. I, p. 729)
Trade and Industrial Code		Trade and Industrial Code in the version made public on January 1, 1978 (BGBl. I, p. 97), last modified by Art. 8 BillBG dated December 15, 1981 (BGBl. I, p. 1390)
ASR 10/1	(4/76)	Workplace Guideline 10/1; Doors, Gates, Issue of April 1976 (made public by the BMA on April 2, 1976, ArbSch. No. 4/1976)
AD Reference Sheet A5	(9/75)	AD Reference Sheet, Openings and Closures of Pressure Vessels
KTA 3201.1	(11/82)	Components of the Pressure Boundary of Light Water Reactors; Part 1: Materials
KTA 3501	(10/81)	Reactor Protection System and Monitoring of Safety Equipment (Modified draft standard: final Version issued 6/85)
KTA 3604	(11/82)	Storage, Handling and Transfer of Radioactive Substances (other than Fuel Elements) in Nuclear Power Plants (Standard 11/82)
Incident Guidelines	(10/83)	Guidelines for the Assessment of the Design of Nuclear Power Plants with Pressurized Water Reactors against Incidents pursuant to Sec. 28 para. 3 StrlSchV - Incident Guidelines - made public by BMI RS 14 - 511 434/2 on October 18, 1983 in Bundesanzeiger No. 245 of December 31, 1983
DIN 25 440	(11/82)	Classification of the Compartments of the Controlled-Access Area of Nuclear Power Plants with Respect to Local Dose Rates