RECOMMENDATION

OF THE

REACTOR SAFETY COMMISSION (RSK) **Date: April 5, 2001**

Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks

At its 338th meeting on March 1, 2001, the RSK recommended the application of the following Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks.

The present text corresponds to the version approved at the 339th meeting of the RSK on April 5, 2001.

In case of discrepancies the German text shall prevail.

Safety Guidelines for Dry Interim Storage of Irradiated Fuel Assemblies in Storage Casks

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1 General

1.1 Scope of application of the Safety Guidelines

The Safety Guidelines shall apply to the dry interim storage of irradiated fuel assemblies in leak-proof storage casks. Irradiated fuel assemblies are defined as fuel assemblies which have reached their planned target burn-up wholly or in part:

More specifically, the Guidelines shall apply to irradiated fuel assemblies

- from light water reactors using uranium dioxide (with and without burnable neutron absorber) or uranium-plutonium dioxide as nuclear fuel

- from high-temperature reactors using uranium oxide, thorium oxide or carbide materials as nuclear fuel and graphite as moderator

- from prototype and research reactors using uranium in the form of oxide, silicite or as uranium-aluminium alloy as nuclear fuel.

The Guidelines shall also apply to the storage of fuel rods in canisters (i. e. after the dissection of the fuel assemblies into individual fuel rods). Fuel assemblies which have undergone repairs or which have had individual rods removed as well as fuel assemblies or fuel rods with defective cladding are also considered in the Guidelines.

Dry interim storage is the temporally restricted safe keeping of irradiated fuel assemblies until their dispatch for the purpose of preparing them for final storage or emplacing them in a repository. The Guidelines relate to metallic casks for the safety keeping of the irradiated fuel assemblies which at the time of emplacement are licensed for transports as Type B (U) package and which are suitable for interim storage according to the state of the art in science and technology.

1.2 Protection goals

The radiological protection goals with which the technical design and the operation of the storage facility have to comply consist of the requirements that[*)]

1. any radiation exposure or contamination of individuals, material goods or the environment be avoided (Section 28 para. 1, clause 1 StrlSchV) /2/;

2. any unnecessary radiation exposure or contamination of individuals, material goods or the environment be kept as low as reasonably achievable (ALARA) - also below the specified limits -

[*)] should be adapted once the new Radiological Protection Ordinance (StrlSchV) has been passed.

taking into account the state of the art and considering all circumstances of each individual case (Section § 28 para. 1, clause 2, Sections 44, 45, 46, 49-55 StrlSchV);

Irrespective of requirement (1), the planning of structural or other engineered protection measures against design basis accidents is to be based analogously on the requirements of Section 28 para. 3 StrlSchV.

Consequently, there are the following fundamental protection goals:

- safe enclosure of the radioactive substances
- safe decay heat removal
- safe maintenance of subcriticality
- avoidance of unnecessary radiation exposure, limitation and control of the radiation exposure of the operating personnel and the population

and the following derived requirements ensue:

- shielding of ionising radiation
- design, implementation and quality assurance in compliance with the requirements for operation and maintenance
- safety-oriented organisation and performance of operation
- safe dispatch of the radioactive substances
- design against accidents and provision of measures to reduce the effects of damage caused by beyond-design-basis events.

There are additional requirements which are not dealt with here, concerning liability /3/, protection against disruptive actions or other third-party intervention /9/ /4/ as well as with regard to the control of fissile material as required by international agreements.

1.3 Terms and definitions

Apart from the technical terms used in connection with nuclear engineering /43/, the technical terms defined below are also relevant for the Guidelines:

a) Discharge of radioactive substances[*)] /2, new/

The discharge of liquid, aerosol-bound or gaseous radioactive substances from facilities and installations on paths provided for this purpose.

b) Activity confinement

[*)] *should be adapted once the new Radiological Protection Ordinance (StrlSchV) has been passed.*

Confinement system consisting of engineered retaining barriers or a combination of engineered and physical retaining barriers, preventing - together with organisational measures - a discharge of radioactive substances.

c) Specified operation /17/

1. Operational processes for which the facility (here: the interim storage facility) is intended and suited (specified operation), given the functional condition of the systems (undisturbed condition).

2. Operational processes which occur in the event of malfunctions of parts of the facility or of systems (disturbed condition) as far as there are no safety-related reasons why operation should be halted (abnormal operation).

3. Maintenance procedures (inspection, maintenance, repair).

d) Release of radioactive substances /17/

The escape of radioactive substances from the confinements provided into the facility or into the environment on paths other than those specified.

e) Maintenance /32/

The entirety of all measures to maintain and restore the specified condition and to ascertain and assess the actual condition. Maintenance is divided into inspection, preventive maintenance and repair.

f) Redundancy /17/

Presence of more functional technical means than necessary to fulfil the intended function.

g) Incident

Event sequence at the onset of which the work can no longer be continued for safety-related reasons and against which the interim storage facility has to be designed or for which precautionary protection measure have to be provided in connection with the activity.

h) Accident*)

Event sequence which for one or several individuals may result in a degree of radiation exposure exceeding the limits indicated in Annex X Table XI Column 2 of the StrlSchV.

i) Storage area

The part of the interim storage facility where the casks are kept.

j) Receiving area

The part of the interim storage facility where the casks are received prior to storage and in which the work necessary before emplacement is carried out. The receiving area also serves for the work that needs to be done prior to the retrieval of the casks.

k) Maintenance area

The part of the interim storage facility where maintenance and repair work can be carried out within the bounds of the facility-specific possibilities.

2 Safety requirements

2.1 Confinement of radioactive substances

The safe confinement of radioactive substances has to be ensured by the fuel assembly casks.

In the case of intact fuel assemblies, the fuel rod cladding serves as additional fuel enclosure. For the storage of defective fuel rods, additional protection measures have to be taken to maintain the mechanical integrity of the inventory and for the sealing system.

2.1.1 Fuel assemblies

*) *should be adapted once the new Radiological Protection Ordinance (StrlSchV) has been passed.*

The mechanical integrity of the fuel assembly structure during storage, handling, shipment and unloading has to be ensured. For the safe keeping of defective fuel rods, special measures are necessary, e. g. gas-tight claddings and/or moisture absorbers.

To preclude a systematic failure of cladding tubes during the storage period, outer cladding corrosion needs to be limited, and the maximum tangential elongation and the maximum tangential stress in the cladding tube need to lie below the material-specific design limits. This applies to the entire storage period of the cask, which is up to 40 years. On providing calculatory safety demonstrations, the operation history of the fuel assemblies has to be taken into consideration.

2.1.2 Casks

The leaktightness of the casks has to be ensured by a double-lid system - with each lid having a metallic seal - or by a volumetrically sealed lid [*)]. In the case of a double-lid system, a metallic seal may be replaced by a weld seam if repairs become necessary.

For the casks on which seals are used as sealing barriers, two independent barriers have to be provided, each with a maximum permissible leakage rate of $1 \cdot 10^{-8}$ Pa · m^3/s[**)] (standard helium leakage rate). These barriers have to be constantly monitored for their leaktightness. In case an impairment of the sealing function is found, a specified repair concept has to be followed. This has to ensure that the twin barrier concept with the specified leaktightness is restored. The thus repaired seal system also has to be constantly monitored for its leaktightness. The residual moisture in the inside of the cask and in the seal system has to be thus limited that the sealing function of the system is not inadmissibly impaired by corrosion over the entire storage period.

If no lid seal system is used but the cask is volumetrically welded gas-tight, there need not be any monitoring of the sealing function if the welding method has been thus qualified that a decrease in the leaktightness of the cask need not be assumed for the entire interim storage period.

The confinement of radioactive substances also has to be ensured for incident and accident conditions, if necessary by an increased leakage rate of the cask (see 2.8 and 2.9).

The repair concept for the casks also has to show which repairs can be carried out at the interim storage facility and which repairs have to be carried out at a different facility.

[*)] *Definition „volumetrically sealed lid“: a lid that is welded onto the main shell of the cask by means of a multi-layer load-carrying seam weld. Through its dimensioning and its design to withstand operational and accident loads and due to the type of the design of the welding in connection with complete welding control through non-desitructive testing (requirements analogous to those for load-bearing weldings according to Technical Rule HIP1 of January 1995), such a seam weld has the same adequate sealing effect like the cask shell and lid.*

[**)] *System-typical acceptance criterion for the seals of the currently licensed casks without quantitative radiological justification..*

2.1.3 Leakage monitoring of the casks

In the case of fuel assembly casks with double-lid systems, the sealing function has to be constantly monitored. A monitoring system has to be used which will send a signal to a central monitoring point as soon as there is a malfunction of one of the two cask sealing systems. The monitoring system has to allow the identification of the cask concerned. The design of the system is to be centred around the ambient conditions prevailing within the storage facility. A self-reporting function of the alarm groups reacting to system-internal disturbances has to be provided as well as a self-reporting system for the failure of individual components.

In the case of fuel assembly casks that are volumetrically welded gas-tight, constant monitoring of the sealing function is not required. However, measures have to be taken with which the sealing function of the weld seam can be demonstrated - without infringing the cask's global integrity - at random and at appropriate intervals during the storage period (e. g. intentional extraction of the atmosphere above the cask, in-service inspection of the weld seam, examination of operation-monitoring test coupons).

2.2 Criticality safety

In connection with the interim storage of irradiated fuel assemblies it is necessary to ensure that during specified normal storage, cask handling and all assumed incidents as well as in the event of an aircraft crash and an external pressure blast wave, the fuel assemblies emplaced as well as their arrangement will remain subcritical. Here, the requirements of DIN 25403, Part 1, have to be fulfilled, especially the safety principles contained therein which relate to the protection against disruptive events and the demonstration of criticality safety /44/.

In connection with the dry storage of irradiated fuel assemblies in casks it is usually necessary to ensure criticality safety by one or several of the following measures:

- limitation of the enrichment of the fuel assemblies (without or with consideration of the burn-up of the fuel assemblies and the associated reduction of the fissile-material content as well as the neutron-absorbing effect of the fission products and actinides)

- limitation of the dimensions and the number of fuel assemblies and specification of their geometric configuration in the fuel basket

- preclusion or limitation of neutron moderation (especially preclusion of inadmissible water volumes in the casks and maintenance of dry conditions in the storage room)

- use of neutron absorbers installed either in the fuel basket or in the emplaced fuel assemblies themselves.

The criticality safety of the storage of the fuel assemblies has to be demonstrated for the most unfavourable conditions expected during normal specified operation. In this demonstration, the calculated neutron multiplication factor k_{eff} must not exceed the limit of 0.95, with calculation uncertainties and fabrication tolerances according to DIN 25403, Part 1, /44/ having to be taken into account in the result.

It also has to be demonstrated that subcriticality is maintained during disturbances and incidents as well, e. g. if the casks are arranged in close packs and especially if they are flooded with water, if they have been wrongly loaded or if the structure of the fuel assemblies and the fuel basket has changed in case it turns out that this may happen during long-term storage.

In the demonstration of criticality safety, any neutron moderators that may possibly exist in combination with the nuclear fuel (e. g. graphite) or that serve for shielding purposes have to be considered. The same applies to the reflection effect of the fuel assembly cask and its surroundings.

As for the demonstration of criticality safety on flooding with water, the respective most unfavourable moderation ratio possible is to be assumed. In this context it has to be considered that there may be repaired fuel assemblies or such fuel assemblies that have had individual fuel rods removed or replaced with different ones.

If fuel rods in canisters (following the dissection of the fuel assemblies into individual fuel rods) are stored instead of fuel assemblies, the most unfavourable moderation ratio possible is to be assumed for the event of the flooding of the multiple-element bottles with water.

If the burn-up of the fuel assemblies is taken into account in the demonstration of criticality safety, the underlying minimum burn-up is to be established by performing measurements on the fuel assembly prior to its emplacement. The requirements of DIN 25471 /45/ and the KTA Safety Standard 3602 /39/ have to be fulfilled.

The criticality safety of the fuel assembly casks and the process of loading them are already examined as part of the licensing process under traffic law. In addition to this licence, it has to be demonstrated that criticality safety is also given under the conditions prevailing during interim storage, especially with respect to the reflection effect of the storage facility and the neutron interaction among the cask arrangement, which may deviate from the boundary conditions of the licence under traffic law.

2.3 Heat removal

The removal of the decay heat of the fuel assemblies has to be ensured in such a way that temperatures arising from the casks and their inventory as well as within the storage building will remain below admissible limits. The safe heat removal to the surrounding area has to take place through natural convection; this means that no active ventilation components/systems are required for this purpose. In justified exceptions it is possible to provide an additional ventilation system for the storage area which can take over the function of operational heat removal. In this case it has to be ensured that no inadmissible temperatures will occur if the active ventilation system fails.

2.3.1 Heat removal from the casks

Heat removal has to be effected in such a way that no cask temperatures will arise that will jeopardise the gamma and neutron radiation shielding or the leak tightness of the cask.

Furthermore, fuel rod temperatures will have to remain low enough to preclude a systematic failure of the fuel rod cladding (see 2.1.1).

2.3.2 Heat removal from the interim storage facility

For the removal of the decay heat generated by the fuel assemblies, the storage building has to have ventilation and exhaust apertures. The air-flow-related design has to be such that the air that is heated up by the casks is removed to the surrounding area and the corresponding volume of outside air is supplied for the casks. Care has to be taken that temperatures arising in the structural elements will be no higher than the design temperatures.

If special boundary conditions of cask emplacement have to be taken into consideration, these have to be specified in an allocation plan. Any possible deviations from this allocation plan have to be reviewed with regard to their safety relevance.

To prevent the formation of considerable amounts of condensed water, ventilation and exhaust apertures may be kept closed in storage areas in which no casks at all or only those casks that do not generate much heat are stored if this does not represent an inadmissible impairment of the heat removal from the casks emplaced. For an optimisation of the necessary air exchange figures and of safe heat removal, detailed regulations are to be included in the operating manual.

2.4 Shielding of ionising radiation

In connection with the interim storage of irradiated fuel assemblies, adequate shielding of the ionising radiation has to be ensured by the fuel assembly cask design and, additionally, by the design of the storage building in order to protect the population and the operating personnel.

For an individual member of the population, the effective dose limit per calendar year is 1 millisievert (mSv). This limit also applies to individuals within the grounds of the facility who are not occupationally exposed to radiation. This limit has to be adhered to when demonstrating the requisite shielding as the sum of the radiation exposure obtained from the direct and scattered radiation of the interim storage facility and with consideration of the contributions to radiation exposure from any discharges and from the direct and scattered radiation emitted by all contributing nuclear facilities at the site. The stay times of an individual of the population - which are decisive for the determination of the radiation exposure resulting from direct and scattered radiation - are governed by the conditions prevailing at the site; if no well-founded reasons are given for a limited stay time, a permanent stay has to be assumed.

The average dose rate limit of the cask surface is 2 mSv/h (with a maximum of 10 mSv/h permissible in some places). Depending on the shielding effect of the building and the radiation sources to be stored, it may be necessary to specify lower cask surface dose rate limits in compliance with the minimisation requirement so that the limit for individuals of the population and for those working within the facility's grounds but not occupationally exposed to radiation can be kept.

On demonstrating the requisite shielding by calculating the radiation exposure in the surrounding area and within the grounds of the facility, gamma and neutron radiation - including any occurring scattered radiation and secondary radiation - have to be taken into account. For these calculations, qualified calculation methods have to be used and their suitability has to be demonstrated. In the calculation, the highest possible gamma and neutron source intensity in the casks and in the entire facility as well as the most unfavourable spatial distribution of the radiation sources, also including transport and handling processes, have to be assumed. If necessary, other radioactive substances that may arise (e. g. radioactive waste, contaminated or activated empty casks) have to be considered in the registration of radiation sources.

With regard to the intended operation of the facility, it has to be checked whether the operator's cabs of cranes and hoists as well as of transport devices that are used in the storage area of the fuel assembly casks have to be shielded against ionising radiation.

As concerns the arrangement of the casks in the storage facility, the best use of the mutual self-shielding effect of the casks is of advantage. However, on specifying the arrangement, the aspects of accessibility and controllability of the casks as well as their thermal influence on each other has to be considered.

For movable additional shields or gates with shielding functions, precautions have to be taken that an inadvertent removal of these shields is avoided and that gates are not left open.

In designing the storage building and especially in designing the ventilation and exhaust apertures, gates, and expansion joints, the aspect of shielding has to be taken into account.

2.5 Radiation protection

2.5.1 Operational radiation protection

Receiving inspection

On reception, fuel assembly casks have to be checked with the help of gamma and neutron dose rate measurements for compliance with the limits applying to the interim storage facility. In addition, incoming casks have to be examined for any surface contamination. Only those casks may be emplaced the surface contamination of which does not exceed the admissible limits according to the Radiological Protection Ordinance[*)] (Annex IX, Column 3). Furthermore, only those casks may be accepted which were loaded in accordance with the Technical Acceptance Criteria (see 2.13.2) of the respective interim storage facility. If emplacement takes place from a neighbouring nuclear power plant without shipment along public transport routes, provisions may be made that certain parts of the controls that have to be executed during the loading process in the nuclear power plant can be dispensed with on emplacement in the interim storage facility.

If several casks are delivered at the same time, an area has to be provided for temporary set-down until the casks have been cleared for emplacement in the storage area. This set-down area has to be designed under the aspects of operational radiation protection.

Exit control

If exiting casks are to be shipped along public transport paths, they have to be checked with the help of measurements for compliance with the local dose rate and surface contamination limits according to traffic law as well as with regard to the fulfilment of the requirements of the accepting facility. Persons, objects and working appliances have to be subjected to a corresponding exit control in accordance with the Radiological Protection Ordinance.

[*)] *should be adapted once the new Radiological Protection Ordinance (StrlSchV) has been passed.*

Radiation protection concept

For interim storage, a radiation protection concept that is based on the accepted radiation protection principles and the requirements of the Radiation Protection Ordinance /2/ is to be worked out and observed and - if necessary - adapted to changed boundary conditions. For specified operation, this radiation protection concept shall cover all operating sequences as well as measures for preventive maintenance, monitoring, measuring, in-service maintenance, repair and for the collection and management of operational radioactive waste; it shall also cover the precautions and measures against accidents and those to cope with emergencies. The responsibilities, competencies and the organisation relating to radiation protection have to be defined clearly and unambiguously. The registration and evaluation of operational radiation-protection-relevant processes and special events has to be ensured. The radiation protection concept has to provide measures to an adequate degree to ensure the technical qualification of the personnel with regard to radiation protection and the promotion of a safety-oriented way of thinking and working.

For the arising repair work, corresponding working appliances and equipment have to be available or obtainable within an adequate period of time. This has to be specified individually. The planning and execution of these activities has to be regulated under radiation protection aspects in a work clearance procedure. /51/

Radiation monitoring in the facility

The whole facility has to be divided into radiation protection areas in accordance with the radiation protection requirements. Here, a differentiation has to be made between monitoring, control and exclusion areas. It should be avoided to have areas with local dose rates that would require the establishment of an exclusion area.

Within the radiation protection areas, the local dose and the local dose rate have to be measured and documented on each change in the inventory, however at least once a year. These measurements have to be performed in representative places and have to record the gamma and neutron doses. Mobile measuring equipment has to be provided to a sufficient extent and has to be used in particular in connection with maintenance measures.

The room air in working areas in which contamination may occur has to be adequately checked for contamination for control purposes, e. g. by means of mobile air sample collectors. Transport areas within the storage area, persons, work places, transport paths and mobile objects have to be checked for contamination in an adequate manner and the results have to be documented. Suitable means to remove contamination have to be provided and organisational specifications have to be made.

Within the framework of health physics concerning the operating personnel, air samples have to be taken regularly in the storage area near the casks emplaced; these samples have to be analysed.

As to gamma and neutron radiation, the body doses of occupationally exposed persons staying in the control area have to be determined and documented with the help of suitable dose meters, e. g. Albedo dose meters. As personal dose meters, state-of-the-art dose meters that can be read at any time are to be used apart from the official dose meters.

The proper functional ability of the equipment provided and used for radiation monitoring has to be checked regularly and systematically.

2.5.2 Radiation protection of the surrounding area

In the case of interim storage facilities, the local dose rate (gamma and neutron dose) has to be monitored in representative places, e. g. at the facility's perimeter fence. The details are regulated by REI /7/.

Interim storage facilities in the neighbourhood of a nuclear facility that disposes of a system to monitor the surrounding area also have to be included in this monitoring system – if necessary by contractual agreements (e. g. through definition of suitable measuring points).

2.6 Structural components

The structural components are erected according to the building codes of the Länder (federal states) in line with generally accepted technical regulations for their intended period of use. In addition, further design requirements ensue from the safety-related analyses concerning normal specified operation of the interim storage facility and relating to incidents:

- Ventilation and exhaust apertures of the storage building have to be arranged and dimensioned such that the safe removal of the decay heat of the fuel assemblies is ensured (cf. 2.3.2).

- The temperature load and ageing resistance of the structural components that results from the heat given off by the casks have to be considered in the design of the building structure (cf. 2.3.2 and 2.15).

- Receiving and maintenance areas have to be design to have surface coatings that are easy to decontaminate.

- The structural parts of the storage building have to have sufficient temperature, pressure and wear resistance. The floor in the storage area has to have a condensed, straightened top coat.

- The base slab of the storage facility has to be designed such that transport vehicles can manoeuvre on it and that it can bear the load of the casks in accordance with the intended emplacement plan. Here, partial emplacement conditions also have to be considered.

- In the design of the building, the impact of loads during transport processes may also have to be considered. In the same way, crane loads and loads of other heavy plant components, e. g. shielding bulkheads, as well as special loads resulting from impacts described in 2.8 and 2.9.1 have to be taken into account.

- The base slab in the storage and receiving area has to be designed such that in the event of a cask crashing onto it from the maximum possible handling height, any damage will be limited such that the safety-related function of the building (stability, shielding and heat removal) will be maintained and repairs will be possible. With regard to the integrity of the casks and the base slab, special measures may be necessary, such as e. g. the use of impact-attenuating material in potential crash areas with greater lifting heights.

- In the design of the building, the intended period of use has to be considered with regard to the durability and functional condition of the building materials and components.

- Both storage and receiving area form one fire section if no considerable fire loads are stored in the receiving area. Adjacent buildings such as office and social wings, laboratories and workshops, have to be structured as separate fire sections.

- With the exception of the decontamination coatings and the building seals, the building materials used for the building accommodating the receiving and storage areas must be "inflammable" (Class A according to DIN 4102-1 /41/) (cf. 2.7.4).

- The building has to be fitted with earthing and lightning protection systems in the sense of the stipulations of KTA Safety Standard 2206 /37/.

- The facilities have to be protected against flooding in the sense of the stipulations of KTA Safety Standard 2207 /38/.

- The storage building has to have a stable design to withstand an earthquake load case in the sense of the stipulations of KTA Safety Standard 2201 /36/ (cf. 2.9.1).

- The storage building has to have a stable design to withstand a fire load case in the sense of the stipulations of DIN 4102, Part 2 to 4 /41/.

2.7 Technical systems

2.7.1 Cranes, hoists and other transport devices

Cranes and hoists that are used for transporting the casks have to be designed in accordance with KTA 3902 /40/; here, additional or more stringent requirements do not usually have to be made if it can be demonstrated that in the event of any handling incidents, sufficient cask integrity is given and the building has been designed to shed any subsequent loads. Regulated drives have to be provided for lifts and motors to ensure safe handling of the casks.

A system has to be provided for the storage hall crane to limit lifting height and to approach pre-selected set-down areas for the casks in the store. For the case of operational disturbances, measures have to be provided to allow the load to be set down.

For the earthquake load case, the stability of the storage hall crane without load has to be demonstrated in accordance with KTA 3902.

In principle it is also possible to employ ground-operated transport vehicles for transporting the casks in the interim storage facility. In this case, the building has to be designed accordingly to withstand the corresponding loads. Impact loads also have to be considered in the design of the building and the casks. Moreover, the effects of a handling incident (a cask crashing or toppling down) have to be analysed.

2.7.2 Ventilation

It must be possible to remove the decay heat of the fuel assemblies at all cask positions from the interim storage facility by passive systems (natural convection).

If active ventilation systems are provided for the storage area, it has to be ensured that the removal of the decay heat of the fuel assemblies by natural convection is not inadmissibly impaired in case of a disturbance or an incident.

The air exchange figures in the storage area are to be thus chosen that the formation of condensed water in considerable amounts is avoided (see 2.3.2). For this purpose it is permissible to adapt the air exchange figures to the heat output of the casks emplaced.

In the maintenance area, an active ventilation or exhaust system has to be provided due to the different conceivable cask maintenance activities (see 2.7.6). As these activities can be interrupted at any time, it is sufficient if in this case it is possible to switch to passive cask cooling by simple pre-planned manual measures.

2.7.3 Electro-technical systems

For the electrical power supply of the interim storage facility, a normal power supply system, a substitute power supply system and an uninterruptible power supply system have to be provided.

The normal power supply system serves for the operation of the storage area and the supply of the infrastructure. The design has to be in accordance with conventional regulations (VDE rules).

The substitute power supply system or second normal power supply system and the uninterruptible power supply system supply important systems. Parts of the lighting and surveillance systems have to be connected to the substitute power supply system. Depending on its safety significance, it is sufficient to design the substitute power supply system as single-train system because no active safety systems are necessary to comply with the safety goals and all ongoing activities can be interrupted at any time without risk.

The uninterruptible power supply system has to supply the security systems, the safety lighting and signal lamps and, if necessary, important IT systems and radiation measurement systems.

2.7.4 Fire protection and fire protection systems

A fire protection concept in accordance with KTA 2101.1 has to be drawn up for the storage building.

During and after fires, cask integrity and sufficient shielding have to be ensured.

The fire protection measures have to be suited for limiting any possible fire loads acting on the fuel assembly casks in handling and storage configuration to such an extent that the dose limits according to Section 28 para. 3 StrlSchV are not exceeded. Here, thermal loads have to be assumed as the ones analysed in connection with the licensing of the casks as Type-B (U) package (800°, 30 minutes duration and respective linear temperature rises and drops within three minutes) unless it can be demonstrated that individual fire loads will be less.

The fire loads in the building have to be minimised. In the storage area, the storage of flammable substances is only permitted if these substances are stored in a condition that precludes their ignition. The design of the fire protection measures has to be in line with DIN 4102 and KTA 2101. Here, the respective most stringent requirement shall apply.

The fire sections of the building may possibly have to be subdivided into fire fighting sections according to the fire protection concept and with consideration of the fire loads. The fire sections and the fire fighting sections as well as their delimitation against each other have to be designed according to KTA 2101.2 in the fire resistance class F90-A as specified in DIN 4102-2. Delimiting walls additionally have to comply with the requirements according to DIN 4102-3, Section 4.3.

The lengths of escape routes in the building - excepting the storage area - must not exceed 50 m running distance each. In the storage area, running distance must be no longer that 120 m at the most.

The removal of fire-related fumes has to be demonstrated to ensure effective fire fighting.

All rooms with fire loads or those which have a fire risk due to their intended use have to be fitted with automatic fire detectors. The storage area does not count among these rooms unless there are any considerable fire loads present.
For fighting initial fires, mobile fire extinguishing systems have to be provided in various locations in the entire building. On choosing the fire-extinguishing agents, possible consequential damage (e. g. through corrosion) has to be taken into consideration.

To ensure effective fire fighting by the local fire brigade or the works fire brigade in charge, the following requirements have to be fulfilled among other things: immediate alerting of the fire brigade, access provided for the fire brigade to reach the object on fire, sufficient space provided for the fire engines and other vehicles, hydrant and supply of fire-extinguishing agent available.

In connection with the fire protection concept, it has to be shown i. a. with regard to possibly occurring substances endangering a body of water whether measures for the retention of water used for fire fighting may be necessary.

The operating personnel have to be trained in the fighting of initial fires.

2.7.5 Treatment of waste and contaminated water

The casks to be emplaced in the interim storage facility have to undergo checks prior to their delivery which also include contamination controls. For this reason, only a very small amount of contaminated waste or by-products and contaminated water is expected.

The operational waste arising, such as e. g. materials from wipe tests, used detergents or the water and operational waste possibly arising in the control area have to be collected in suitable containers. Before any water is discharged, it has to be checked for its activity. Depending on the measuring result, this water may be cleared for discharge or passed on to the owners of other licenses. /14/

As regards the management of radioactive waste, the BMU Guideline /6/ has to be observed on collecting, labelling and processing this waste as well as in connection with the corresponding documentation.[*)] As regards non-radioactive waste and waste water, the requirements of the corresponding waste and water acts have to be observed.

Details regarding the treatment of waste and by-products have to be regulated in the operating manual.

[*)] *should be adapted once the new Radiological Protection Ordinance (StrlSchV) has been passed.*

2.7.6 Receiving and maintenance area

Both a receiving and a maintenance area have to be provided in the interim storage facility that are separate from the storage area since certain activities are necessary before emplacement and retrieval of the casks. In addition, the need for a certain extent of maintenance and repair work cannot be precluded. Work involving the opening of the primary lid is only admissible if a hot cell is provided.

In the maintenance area, a crane has to be available for transporting components of the lid system. With regard to possibly necessary work involving a release of contaminants, such as e. g. welding or varnishing, suitable ventilation or exhaust systems have to be provided. For welding, additional suitable protection measures have to be provided. If a release of radioactive substances cannot be precluded in connection with work on the casks, specific exhaust systems with HEPA filters and sampling systems have to be provided for the protection of the personnel.

2.8 Internal impacts

It has to be investigated in an accident analysis which operational disturbances and incidents may arise in connection with the interim storage of the irradiated fuel assemblies. For this purpose, the storage conditions including possible long-term effects and the operational processes have to be analysed systematically, and experiences from similar plants have to be considered.

From this analysis, the design basis accidents for interim storage have to be derived and marked off from the operational disturbances that belong to abnormal operation. Human errors have to be taken into account in the analysis of the possible incidents.

In connection with the dry storage of irradiated fuel assemblies, the following plant-internal events are usually considered as design basis accidents:

1. Mechanical impacts, such as

    - the crash of a fuel assembly cask from the maximum possible height in the least favourable impact position and with consideration of the highest and the lowest cask temperatures,

    - the toppling of a fuel assembly cask during handling

    - the crash of the maximum possible load onto the fuel assembly casks

2. Fire

    The maximum of stationary and temporary fire loads that may be present in the store have to be considered. In addition to the demonstrations to be provided for the integrity of the casks and the sealing function as described in 2.7.4, possible fires in the facility involving potential activity releases have to be analysed. Flammable operational waste and temporarily present potential fire sources have to be considered in the incident analyses.

Also, failures of the following important systems have to be considered as abnormal operating states:

- failure of the electricity supply,
- failure of instrumentation and control systems,
- failure of hoist, cranes and transport vehicles,
- failure of ventilation systems or active components relevant for heat removal.

For the design basis accidents, compliance with the requirements of Section 28 para. 3 StrlSchV has to be demonstrated by means of calculations of the possible radiological consequences unless the occurrence of the incident can be precluded due to the precautions that have been taken and a calculation of the radiological consequences is not necessary in accordance with /15, paragraph 4.10/. As for the abnormal operating states, compliance with the limits of Sections 44 and 45 StrlSchV has to be demonstrated.

2.9 External impacts

In connection with the dry storage of irradiated fuel assemblies, the following external impacts usually have to be considered:

- external impacts caused by nature, such as storms, rain, snowfall, frost, lightning, flooding, landslides, earthquakes
- external impacts caused by civilisation, such as impacts of harmful substances, pressure blast waves from chemical explosions, fires spreading from outside (forest fires), mines caving in, aircraft crashes.

If necessary, special site-specific aspects have to be considered in addition.

Possible interactions with neighbouring nuclear facilities are dealt with under 2.10. External impacts brought on by intentional third-party intervention are considered in connection with the protection against disruptive actions and other cases of third-party intervention /9/ and /4/.

2.9.1 External impacts caused by nature

External impacts caused by nature have to be considered as operational loads or as design basis accidents. The load assumptions for these impacts caused by nature have to be specified in accordance with the site conditions.

1. For the design against storms, rain, snowfall and frost, the most adverse weather conditions expected at the site have to be assumed.

2. The storage building has to be protected against lightning in the sense of KTA 2206 /37/ and according to the relevant VDE Guidelines and Regulations.

3. The site of the interim storage facility should be safe from flooding. If flooding through high tides cannot be precluded, the interim storage facility has to be protected against flooding in accordance with the requirements of KTA 2207. /38/

4. As concerns the consideration of the earthquake load case, the design basis to be used is the highest intensity that may occur at the site according to scientific knowledge, with consideration of a wider surrounding area around the site (up to about 200 km from the site). Here, the assumptions are to be based on the principles specified in KTA 2201.1 /36/.

5. The integrity, stability and subcriticality of the emplaced casks holding the irradiated fuel assemblies have to be ensured for the design earthquake. Earthquake impacts on technical systems - such as hoists, cranes, shielding doors - or on the storage building must not lead to any inadmissible radiological consequences for the population according to Section 28 para.3 StrlSchV.

2.9.2 External impacts caused by civilisation

It has to be shown within the framework of a safety analysis which effects have to be expected from external impacts caused by civilisation. The decision about which events have to be classified as design basis accidents in the sense of Section 28 para. 3 StrlSchV and whether (and if yes, which) protection measures are necessary under the aspect of mitigating the effects of the damage caused by those events which due to their low frequency of occurrence are not to be classified as design basis accidents has to be oriented in particular on the results of the safety analysis and on the effects these events have on the area surrounding the facility.

The load assumptions for external impacts caused by civilisation shall be made according to the state of the art in science and technology, with consideration of the site conditions.

In all cases, measures to restrict the damage from an aircraft crash or an external pressure blast wave have to be taken, applying the load assumptions of the RSK Guidelines for Pressurised Water Reactors /22/ and the BMI Guideline for the protection of nuclear power plants against pressure blast waves /23/. The requirement of reducing the damage consequences can be considered as fulfilled if even in events like these the radiological consequences calculated under realistic boundary conditions make no drastic accident management measures necessary (see Section 7(2a) in /1/). The reduction of the effects of the damage resulting from an aircraft crash or a pressure blast wave can be achieved either by the design of the casks or by a combination of cask and storage facility/storage building design.

If the casks get damaged or are buried as the result of impinging components, pieces of debris or technical systems, consequential fires or debris loads, this must not lead to criticality, and the integrity and heat removal of the casks must not be impaired in an inadmissible manner.

2.10 Interactions with existing nuclear facilities

If further nuclear facilities or former activities falling under the scope of the Radiological Protection Ordinance contribute to the radiation exposure of the population at the site of the interim storage facility, they have to be taken into account in the initial radiation exposure. The limit of 1 mSv per year applying to individual members of the public has to be kept with consideration of the direct and scattered radiation and the discharges from these nuclear facilities.

If the interim storage facility is to be erected in the direct neighbourhood of a nuclear power plant, the following events within the power plant grounds have to be considered and the effects on the interim storage facility examined:

- the stack or other structural components toppling down
- turbine failure
- failure of vessels with high energy content.

In addition, access to the interim storage facility and to the neighbouring nuclear facility has to be ensured.

2.11 Autonomy of the interim storage facility

In the case of interim storage facilities in the direct neighbourhood of another operating nuclear facility it is admissible to use a joint infrastructure. This includes i. a.:

- instrumentation and control systems,
- environmental monitoring systems,
- physical protection systems,
- supply and disposal of media, including electricity supply,
- general services,
- personnel.

In case of a joint use, care has to be taken that the operation of the interim storage facility is not impaired in a way that would be inadmissible from a safety-related point of view. It also has to be ensured that the signals of the cask surveillance system will also be shown in the interim storage facility.

If the operation of the interim storage facility is planned for a period beyond the projected operating time of the neighbouring nuclear facility the systems of which are shared, a concept has to be presented that shows up measures to establish self-sufficient operation of the interim storage facility following the decommissioning of the neighbouring nuclear facility. In this context, the repair concept for the casks also has to be adapted.

Joint interim storage of irradiated fuel assemblies as dry storage in casks with the associated equipment for handling and transporting the casks as well as with radioactive waste and with components from the decommissioning of a power plant facility is possible if the latter are in solid form and do not represent an impairment of the safety of interim irradiated-fuel assembly storage. In this connection, the possible influences of these materials which might affect the safety of interim storage have to be analysed. In particular, any connected additional fire loads, the moderating effect of certain substances with regard to maintaining criticality safety, and additional handling processes have to be considered.

The storage of irradiated fuel assemblies in casks has to be separated in a suitable manner from the storage of radioactive waste in the sense of proper storage through keeping certain distances or providing separations. The emplacement and retrieval processes of the radioactive waste packages or of components from the decommissioning of a power plant facility have to be organised such that damaging of the fuel assembly casks emplaced is precluded.

2.12 Quality assurance

During the planning and design of the interim storage facility already, a quality assurance concept that is graded according to safety requirements has to be worked out for the construction and operation of the facility. For this purpose it is expedient to make a quality classification of all systems, parts and components according to their safety-related or radiological significance.

The accompanying quality control shall comprise the design review, in-process inspections, and acceptance and functional tests. The scope of the accompanying controls is to be specified in accordance with the respective quality class that corresponds to the safety-related requirements. The principle procedure has to take place in line with DIN ISO 9000 ff and in the sense of KTA 1401 /32/. For the documentation, the principle of KTA 1404 /33/ shall apply.

As far as any in-service inspections have to be performed within the framework of quality assurance measures during normal specified operation, the conception and the design of the facilities is to be such that the area to be inspected can be accessed unhindered and the inspections can be performed with low radiation exposure of the personnel. The kind and scope of the involvement of experts in the inspection has to be specified for initial tests and in-service inspections.

For the manufacturing of the casks, the conditions specified in the memorandum of BAM, BfS and TÜV Hannover/Sachsen-Anhalt e. V. /50/ shall apply.

2.13 Operation of the facility

The interim storage facility has to be operated such that the damage precautions necessary according to the state of the art have been taken. Special attention has to be paid to the following points:

- all processes leading to the first-time achievement of normal specified facility operating conditions (commissioning),
- normal specified operation,
- detection and control of accidents and elimination of their consequences.

The entire operation has to be structured in a suitable manner to ensure the safe performance of these operational processes. In particular, the necessary administrative prerequisites concerning staffing, organisation and safety have to be created and demonstrated. Clear instructions concerning the operational processes as well as for the control of accidents and the elimination of accident consequences have to be elaborated and compiled in an operating manual. Competencies and responsibilities have to be clearly defined.

2.13.1 Commissioning

Prior to the start of storage operation, all systems in the storage facility have to undergo commissioning tests. These tests have to be specified in a commissioning programme.

Prior to first emplacement in a facility, cold testing has to be performed with one cask each of every cask type licensed for emplacement for the entire handling and clearance sequence, including the radiation protection measures.

2.13.2 Operation

An operating manual in the sense of KTA 1201 /29/ has to be prepared which shall describe all operational processes as well as the measures to be taken in case of an accident in the form of clear operating instructions. In particular, all aspects with relevance to safety have to be addressed. Additionally, the procedure in connection with modifications or the supplementation of parts of the facility and of procedures has to be specified.

The assumptions and boundary conditions applied in the safety analyses for the cask characteristics and the fuel assemblies have to be summarised in Technical Acceptance Criteria for the interim storage facility. Implementation instructions have to be prepared to demonstrate that the Technical Acceptance Criteria are observed. These also include work procedures and test instructions that have to be observed in connection with the loading of the casks.

Relevant systems have to be subjected to in-service inspections. These in-service inspections have to be specified in an inspection manual in the sense of KTA 1202 /30/.

The operation of the plant has to be monitored to the effect that safety-significant operational disturbances and incidents can be reliably detected and the countermeasures specified in the operating manual can be taken. Fault alarms have to be centrally registered and documented.

Records have to be kept about safety-significant events. Safety-relevant findings from the facility's commissioning, normal specified operation (especially repairs) and in-service inspections have to be documented. The kind and scope of this documentation has to be specified.

Experiences from the operation of similar facilities have to be taken into account in the facility's own operational management. For this purpose, procedures have to be provided that ensure the exchange of experiences among facility operators (e. g. on the basis of operation reports).

The technical systems that are used for the dispatch of the fuel assembly casks have to be available for as long as it takes until the last cask holding fuel assemblies has been dispatched.

2.13.3 Maintenance

All systems requiring inspection or maintenance have to be structured in a way that makes them easily accessible, or access to them has to be provided through technical devices. Spatial conditions have to be thus that there is sufficient room for maintenance work, with necessary additional shielding possibly having to be provided for reasons of radiation protection. Instructions for the execution of maintenance activities have to be included in the operating manual.

2.13.4 Personnel

The facility must dispose of qualified personnel in sufficient numbers. This personnel has to ensure safety and has to be trained on a regular basis. This also applies if personnel from the neighbouring nuclear facility are used. The technical qualification depending on the staff member's position has to be demonstrated according to the requirements of the Radiological Protection Ordinance or other special regulations. The requirements regarding the responsibility in questions of nuclear safety are regulated by the Atomic Energy Act and the Radiological Protection Ordinance.

2.14 Emergency preparedness

A plan of operational emergency measures has to be worked out and may possibly have to be co-ordinated with the emergency protection plan of neighbouring nuclear facilities as well as with the local and regional/national authorities in charge. Copies of the operational emergency protection plan have to be on hand at any time at a constantly manned position. If necessary, further copies shall be provided to the neighbouring nuclear facilities, the authorities in charge and the safety bodies concerned.

2.15 Long-term and ageing effects, long-term monitoring

To control long-term and ageing effects during the applied-for period of use of the interim storage facility, a monitoring concept has to be presented. Here, a general distinction has to be made between parts and components that are designed for the entire period of use of the facility and those that may possibly have to be replaced.

Among the parts and components that have to be designed for the entire period of use of the facility or the respective cask are the storage casks for the fuel assemblies - including the system to monitor the leaktightness of these casks - as well as the building itself. It is especially the safety-relevant cask components such as e. g. the sealing barrier and the neutron moderator that have to have the requisite longevity. Here, one has to differentiate between the period of use of the storage facility and that of the cask.

The necessary safety-related functions of the systems, parts and components have to be ensured for the entire operating period. The condition of the lifting trunnions of the casks in particular has to allow the casks to be moved within the facility at any time.

As concerns the parts and components which may need to be replaced, it has to be taken care that these activities can be performed without any major impairment of operations in the interim storage facility and preferably shielded from the radiation field around the storage casks. In this context, adequate access has to be provided.

The monitoring concept has to ensure that the overall condition of the plant is monitored and has to fulfil at least the requirements listed below:

- At intervals of 10 years, the facility operator regularly has to prepare a report about the condition of the storage building and of the components necessary for interim storage.

- The condition of the storage building and of the components necessary for interim storage has to be inspected by walk-down and suitable measurements.

- Recurrent settlement measurements have to be performed for the storage building.

- Random inspections of the storage casks have to be carried out.

- The results of recurrent inspections have to be evaluated.

2.16 Decommissioning

The interim storage facility for irradiated fuel assemblies has to be designed and built such it can be decommissioned and can either be made further use of or removed in compliance with the radiation protection regulations. Prior to any further use or the dismantling of the storage building, it has to be demonstrated by measurements that the building is not contaminated or has been sufficiently decontaminated and is free of any inadmissible activation. The requirements under building and waste law have to be observed.

3 Relevant instructions, guidelines and standards

The following instructions, guidelines and standards - irrespective of whether or not they have been cited in the above Guidelines - are relevant for the dry interim storage of irradiated fuel assemblies in storage casks:

/1/ Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz - AtG) vom 23. Dezember 1959, Neufassung vom 15. Juli 1985 (BGBl. I. 1565), zuletzt geändert durch Gesetz vom 03. Mai 2000 (BGBl. I. S. 636)

/2/ Verordnung über den Schutz vor Schäden durch ionisierende Strahlen (Strahlenschutzverordnung – StrlSchV) vom 30. Juni 1989 (BGBl. I. S. 1321, 1926), zuletzt geändert durch Verordnung vom 18. August 1997 (BGBl. I. S. 2113)

/3/ Verordnung über die Deckungsvorsorge nach dem Atomgesetz (Atomrechtliche Deckungsvorsorge-Verordnung – AtDeckV) vom 25. Februar 1977 (BGBl. I. S. 220), geändert durch 6. Überleitungsgesetz vom 25. September 1990 (BGBl. I. S. 2106)

/4/ Sicherung von Zwischenlagern für bestrahlte Brennelemente aus Leichtwasser-reaktoren an Kernkraftwerksstandorten in Transport- und Lagerbehältern gegen Störmaßnahmen oder sonstige Einwirkungen Dritter
(Stand: 7. August 2000); BMU-Erlass vom 1. Dezember 2000 – RS I 3 – 14640 – 1/7
VS-NfD

/5/ Allgemeine Verwaltungsvorschrift zu § 45 StrlSchV: Ermittlung der Strahlenexposition durch Ableitung radioaktiver Stoffe aus kerntechnischen Anlagen oder Einrichtungen, 21. Februar 1990 (Bundesanzeiger Nr. 64 a vom 31.03.1990)

/6/ BMU
Richtlinie zur Kontrolle radioaktiver Abfälle mit vernachlässigbarer Wärmeentwicklung, die nicht an eine Landessammelstelle abgeliefert werden (Abfall-Richtlinie) vom 16. Januar 1989 (Bundesanzeiger 1989, Nr. 63a), letzte Ergänzung vom 14. Januar 1994 (Bundesanzeiger 1994, Nr. 19)

/7/ Richtlinie zur Emissions- und Immissionsüberwachung kerntechnischer Anlagen (REI) vom 30. Juni 1993 (GMBl. 1993, Nr. 29), zuletzt geändert am 20. Dezember 1995 (GMBl. 1996, Nr. 9/10) einschließlich der Anhänge

/8/ Grundsätze für die ärztliche Überwachung von beruflich strahlenexponierten Personen, 1978
(Schriftenreihe des Bundesministers des Innern, Band 9, Verlag W. Kohlhammer, Stuttgart)

/9/ Richtlinie über Maßnahmen für den Schutz von Anlagen des Kernbrennstoffkreislaufes und sonstigen kerntechnischen Einrichtungen gegen Störmaßnahmen oder sonstige Einwirkungen zugangsberechtigter Einzelpersonen vom 28. Januar 1991 (GMBl. 1991 S. 228)

/10/ Verordnung über Arbeitsstätten (Arbeitsstätten-Verordnung – ArbStättV) vom 25. März 1975 (BGBl. I. S. 729), zuletzt geändert durch Verordnung vom 04. Dezember 1996 (BGBl. I. S. 1481)

/11/ Arbeitsstätten-Richtlinien (ASR) Bundesminister für Arbeit und Sozialordnung ASR 10f1 vom April 1976, ASR 17/1.2 vom September 1976 und Januar 1988

/12/ Rahmenempfehlungen für den Katastrophenschutz in der Umgebung kerntechnischer Anlagen vom 09. August 1999 (GMBl. 1999, Nr. 28/29)

/13/ Richtlinie für die physikalische Strahlenschutzkontrolle zur Ermittlung der Körperdosen (§§ 62, 63, 63 a StrlSchV, §§ 35, 35 a RÖV) vom 20. Dezember 1993 (GMBl. 1994, Nr. 7) sowie Berechnungsgrundlage für die Ermittlung der Körperdosis bei innerer Strahlenexposition (Richtlinie zu § 63 StrlSchV) vom 19. August 1981 (BGTBl. 1981, S. 322)

/14/ BMU
Schreiben an die für den Vollzug der Strahlenschutzverordnung zuständigen obersten Landesbehörden
Vollzug der Strahlenschutzverordnung
Freigabe von Stoffen mit geringfügiger Aktivität
Bonn, 28.05.1998

/15/ Leitlinien zur Beurteilung der Auslegung von Kernkraftwerken mit Druckwasserreaktoren gegen Störfälle im Sinne des § 28 Abs. 3 StrlSchV – Störfall-Leitlinien – 18. Oktober 1983 (Bundesanzeiger Nr. 245 a vom 31. Dezember 1983)

/16/ Rundschreiben des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit vom 17. Oktober 1995, RS II 5 – 11434/8 mit Neufassung des Kapitels 4, „Berechnung der Störfallexposition“ (Bundesanzeiger Nr. 222 a vom 26. November 1994) der Störfallberechnungsgrundlagen für die Leitlinien unter /15/

/17/ Sicherheitskriterien für Kernkraftwerke, Bundesanzeiger Nr. 206 vom 3. November 1977

/18/ SSK-Empfehlung
Freigabe von Materialien, Gebäuden und Bodenflächen vom 12. Februar1998, Bundesanzeiger vom 15.Oktober 1998, S. 15022

/19/ Bundesamt für Strahlenschutz
Leitfaden zur Stilllegung von Anlagen nach § 7 Atomgesetz vom 14. Juni 1996

/20/ BMU
Schreiben vom 05.-09.2000, Az.: RS II 1 – 11413/28
Vollzug der Strahlenschutzverordnung, Vollzugshinweise zur unmittelbaren Wirkung der Richtlinie 96/29 EURATOM und 97/43 EURATOM

/21/ BMU
Schreiben vom 07. Juni 1999
„Kriterien zur Beförderung von entleerten Brennelementen-Behältern, Behältern mit bestrahlten Brennelementen aus Leistungsreaktoren und Behältern mit verglasten hochradioaktiven Spaltproduktlösungen“

/22/ RSK-Leitlinien für Druckwasserreaktoren
3. Ausgabe vom 14.10.1981 (BAnz. 1982, Nr. 69a) mit den Änderungen:
in Abschn. 21.1 (BAnz. 1984, Nr. 104)
in Abschn. 21.2 (BAnz. 1983, Nr. 106) und
in Abschn. 7 (BAnz. 1996, Nr. 158a) mit Berichtigung (BAnz 1996, Nr. 214)
Stand: 12/98

/23/ Richtlinie für den Schutz von Kernkraftwerken gegen Druckwellen aus chemischen Reaktionen durch Auslegung der Kernkraftwerke hinsichtlich ihrer Festigkeit und induzierter Schwingungen sowie durch Sicherheitsabstände (Stand: August 1976)

BAnz. Nr. 179 vom 22. September 1976

/24/ Gesetz zum Schutz vor gefährlichen Stoffen (Chemikaliengesetz - ChemG) in der Fassung der Bekanntmachung vom 25. Juli 1994 (BGBl. S. 1703), zuletzt geändert durch Gesetz vom 14. Mai 1998 (BGBl. I. S. 950)

/25/ Verordnung zum Schutz vor gefährlichen Stoffen (Gefahrstoffverordnung - GefStoffV) vom 26. Oktober 1993 (BGBl. I. S. 1782 bzw. S. 2049) zuletzt geändert durch Gesetz vom 26. Juni 2000 (BGBl. I. S. 932)

/26/ Gesetz über die Umweltverträglichkeitsprüfung (UVPG) vom 12. Februar 1990 (BGBl. I. S. 205), zuletzt geändert durch Gesetz vom 18. August 1997 (BGBl. I. S. 2081)

/27/ Allgemeine Verwaltungsvorschrift zur Ausführung des Gesetzes über die Umweltverträglichkeitsprüfung (UVPVwV) vom 18. September 1995 (GMBl. 1995 S. 671, Nr. 72)

/28/ Gesetz zum Schutz von schädlichen Umweltweinwirkungen durch Luftverunreinigungen, Geräusche, Erschütterungen und ähnliche Vorgänge (Bundes-Immissionsschutzgesetz – BImSchG) in der
Fassung der Bekanntmachung vom 14. Mai 1990 (BGBl. I. 1990 S. 880), zuletzt geändert durch Gesetz vom 03. Mai 2000 (BGBl. I. S. 633)

/29/ KTA 1201
Anforderungen an das Betriebshandbuch; Fassung 6/98

/30/ KTA 1202
Anforderungen an das Prüfhandbuch; Fassung 6/84

/32/ KTA-Regel 1401:
Allgemeine Anforderung an die Qualitätssicherung, Fassung 11/86

/33/ KTA 1404
Dokumentation beim Bau und Betrieb von Kernkraftwerken
Fassung 6/89

/34/ KTA 2101.2
Brandschutz in Kernkraftwerken, Teil 2, Baulicher Brandschutz, Fassung 12/00
KTA 2101.1
Brandschutz in Kernkraftwerken, Teil 1: Grundsätze des Brandschutzes,
Fassung 12/00

/35/ KTA 2102
Rettungswege in Kernkraftwerken; Fassung 6/90

/36/ KTA 2201 Auslegung von Kernkraftwerken gegen seismische Einwirkungen,
Teil 1 Grundsätze, Fassung 6/90;
Teil 2 Baugrund, Fassung 06/90;
Teil 3 Auslegung der baulichen Anlagen (Entwurf), Fassung 06/90
Teil 4 Anforderungen an Verfahren zum Nachweis der Erdbebensicherheit für
maschinen- und elektrotechnische Anlagenteile, Fassung 06/90

/37/ KTA 2206
Auslegung von Kernkraftwerken gegen Blitzeinwirkungen
Fassung 6/00

/38/ KTA-Regel 2207:
Schutz von Kernkraftwerken gegen Hochwasser, Fassung 6/92

/39/ KTA 3602:
Lagerung und Handhabung von Brennelementen, Steuerelementen mit Neutronenquellen in Kernkraftwerken mit Leichtwasserreaktoren.
KTA 3602/00/2, Fassung März 2000

/40/ KTA-Regel 3902: Auslegung von Hebezeuge in Kernkraftwerken, Fassung 6/92

/41/ DIN 4102 mit den Teilen 1 bis 4
Brandverhalten von Baustoffen und Bauteilen
(Teil 1: Fassung 05/98; Teil 2: Fassung 09/77; Teil 3: Fassung 09/77; Teil 4: Fassung 03/94, zuletzt berichtigt 09/98)

/42/ DIN 4149, Teil 1: „Bauten in deutschen Erdbebengebieten, Lastannahmen, Bemessungen und Ausführung üblicher Hochbauten“
April 1981

/43/ DIN 25401, Kerntechnik Begriffe, Teile 1-9, September/November 1986

/44/ DIN 25403: Kritikalitätssicherheit bei der Herstellung und Handhabung von Kernbrennstoffen, Teil 1, Grundsätze.
Dezember 1991

/45/ DIN 25471: Kritikalitätssicherheit unter Anrechnung des Brennelementabbrandes bei der Lagerung und Handhabung von Brennelementen in Brennelementlagerbecken von Kernkraftwerken mit Leichtwasserreaktor.
September 2000

/46/ DIN 25474: Maßnahmen administrativer Art zur Einhaltung der Kritikalitätssicherheit in kerntechnischen Anlagen ausgenommen Reaktoren. Juli 1996

/47/ International Atomic Energy Agency: Regulations for the Safe Transport of Radioactive Material. Safety Series No. 6, 1985 Edition (As Amended 1990) vgl. auch Rn Nr. 2700 der Anlage A der GGVS) sowie: Regulation for the Safe Transport of Radioactive Material (1996 Edition) revised No. TS-R-I

/48/ IAEA Safety Series N° 116: Design of Spent Fuel Storage Facilities, 1994

/49/ IAEA Safety Series N° 117: Operation of Spent Fuel Storage Facilities, 1994

/50/ Vermerk BAM III 3, BfS ET-S2, TÜV H-S/A vom 03. September 1997 i. d. F. vom 14. Januar 1998: „Maßnahmen zur Qualitätssicherung und –überwachung bei der Fertigung und Inbetriebnahme der verkehrsrechtlich zugelassenen Behälter zur Zwischenlagerung radioaktiver Stoffe“

/51/ Richtlinien für den Srahlenschutz des Personals bei der Durchführung von Instandhaltungsarbeiten in Kernkraftwerken mit Leichtwasserreaktor

Teil I Die während der Prüfung der Anlage zu treffende Vorsorge
Teil II Die Strahlenschutz-Maßnahmen während der Inbetriebsetzung und des Betriebes der Anlage

Rundschreiben des BMI, Teil I, 10.07.1978/RS II 3 – 515 800/5
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