
RSK Recommendation

Safety requirements on the interim storage of low and intermediate level waste in the longer term

As amended on 05.12.2002
with new wording in Section 2.7.1 (third bullet) of 16.10.2003

Note:

With the recommendation of the Nuclear Waste Management Commission (ESK) [“Guidelines for the storage of radioactive waste with negligible heat generation”](#) (revised version of 10.06.2013) [in German], the recommendation of the Reactor Safety Commission (RSK) (of 05.12.2002) was updated.

CONTENTS

1	General remarks	3
1.1	Scope of application	3
1.2	Protection goals	4
1.3	Terms and definitions	5
2	Safety requirements	8
2.1	Enclosure of radioactive materials	8
2.1.1	Waste products and packages	8
2.1.2	Waste containers	11
2.1.3	Storage building	11
2.2	Criticality safety	12
2.3	Radiation protection	12
2.3.1	Radiation protection concept	12
2.3.2	Shielding of ionising radiation	13
2.3.3	Radiation protection areas and operational radiation protection	13
2.3.4	Radiation protection of the environment	14
2.4	Structural requirements for new storage buildings	14
2.5	Technical equipment	15
2.5.1	Hoisting equipment and other transport devices	15
2.5.2	Room air conditioning	16
2.5.3	Electrotechnical equipment	16
2.5.4	Fire protection and fire protection equipment, explosion protection	16
2.6	Internal impacts	16
2.7	External events	19
2.7.1	Natural external events	19
2.7.2	Man-induced external events	19
2.8	Interaction with existing nuclear installations	20
3	Quality assurance and product control	20
3.1	Procedure qualification	21
3.2	Qualification of the waste containers	22
3.3	Documentation	22
3.4	Old wastes	24
4	Operation of the interim storage facilities	24
4.1	Operation principles	25
4.2	Commissioning of newly constructed storage facilities	25
4.3	Operation	26
4.4	Maintenance	29
4.5	Personnel	29
4.6	Emergency preparedness	30
4.7	Long-term and ageing effects, long-term monitoring	30
5	Regulations, guidelines and standards	33

Appendix:

Flow chart on product control of waste packages from nuclear installations (Example /8/)

1 General remarks

For the interim storage of low and intermediate level waste, more or less short periods of time were taken into consideration so far. Thus, the conditioning (i. e. processing and packaging) of these radioactive wastes is currently oriented towards interim storage periods of some years. According to current developments, however, an interim storage period of up to 40 years until beginning of the final disposal of radioactive wastes cannot be excluded. The safety requirements refer to the safe storage of radioactive wastes in the longer term in already existing facilities and those to be erected for this period.

The development of the safety requirements was based on the assumption that there will be definite conditions for final disposal. /10/ delineates the approaches and contents for the development of these site-independent disposal conditions.

The licensed concepts of the existing storage facilities are not regarded as exclusive standard. There is rather a compilation of basic safety requirements for interim storage in the longer term. Thus, other concepts have also been taken into consideration.

1.1 Scope of application

These safety requirements are applicable to installations and facilities for the interim storage of low and intermediate level wastes in the longer term which are subject to licensing pursuant to Sections 6, 7, 9 of the Atomic Energy Act (AtG) /1/ and Section 7 of the Radiation Protection Ordinance (StrlSchV) /2/. The low and intermediate level wastes taken into consideration come from the operation and dismantling of nuclear installations and also other use of radioactive material in industry, medicine, research and at the Federal Armed Forces. At present, the wastes are either stored in central interim storage facilities, in local storage facilities at the sites of the nuclear installations or in the public and private collecting facilities. Old wastes (see definition in Chapter 3.4) are included here.

Besides the interim storage of radioactive wastes with the aim to store them in a repository, the storage of waste material with the aim of radioactivity decay also gains in importance due to the longer storage periods. The same safety requirements as required for the interim storage of radioactive wastes with the objective of later final disposal are to be applied – as far as transferable - to the longer-term decay storage or buffer storage with the objective of release from regulatory control or later conditioning for final disposal under more favourable radiological conditions.

The period of short-term decay storage for the release of nuclear material from regulatory control for a non-hazardous re-use or conventional disposal (Section 29 StrlSchV /2/) is generally less than five years. This decay storage is not addressed in this paper.

The objective of the safety requirements is to identify all safety-relevant influencing parameters resulting from a longer-term interim storage of low and intermediate level wastes or residual material. In this respect, all boundary conditions should be considered that, from today's point of view, should be fulfilled before

interim storage of the wastes, irrespective of whether disposal in a repository or release from regulatory control is intended.

1.2 Protection goals

The radiological protection goals with which the longer-term interim storage of low and intermediate level wastes have to comply consist of the requirements that

1. any unnecessary radiation exposure or contamination of man and environment shall be avoided (Section 6, para 1 StrlSchV), and
2. any radiation exposure or contamination of man and the environment shall be kept as low as practicable even where values are below the authorised limits, taking due account of the state of the art in science and technology and of the conditions of each individual case (Section 6 para 2 StrlSchV).

Irrespective of requirement 1, the planning of structural or other engineered protection measures against design-basis accidents shall be based on the requirements of Sections 49 and 50 StrlSchV.

Consequently, there are the following fundamental protection goals for the waste packages, the storage facility with the technical equipment and storage facility operation:

- Safe enclosure of the radioactive materials,
- avoidance of any unnecessary radiation exposure, limitation and control of the radiation exposure of operating personnel and the population, and, where applicable,

for special wastes also

- safe maintenance of subcriticality, and
- safe decay heat removal,

as well as the following derived requirements:

- 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 handling, transport of radioactive materials at the site and their removal from the site,
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- design against incidents, and,
 - as far as required due to the release potential, measures for the mitigation of consequences of beyond-design-basis accidents.

There are additional requirements which are not dealt with here, concerning liability, protection against disruptive actions or other third-party intervention and, in the individual case, the control of fissile material as required by international agreements.

1.3 Terms and definitions

In addition to the terms used in the field of nuclear technology and defined in the industrial standard DIN 25401-9 /3/ and Section 3 of the Radiation Protection Ordinance (StrlSchV), the following definitions of terms are of relevance to the following safety requirements:

– **Waste**

Radioactive materials not intended for non-hazardous recycling, but for disposal according to specified regulations (Section 3 StrlSchV).

– **Waste treatment**

Processing of radioactive wastes to waste products

– **Waste packages**

A waste package is the waste product together with the waste container used (also in the case of intermediate products or raw wastes). Thus, the characteristics of the package are the sum of the characteristics of waste product and waste container.

– **Waste product**

Processed waste without packaging.

- **Waste conditioning**

Waste treatment according to defined procedures with the objective to produce waste packages which meet the requirements for intermediate storage or final disposal.

- **Discharge of radioactive materials**

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

- **Activity confinement**

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 materials.

- **Fire load**

The fire load comprises all combustible materials contained in an area that can contribute to a fire.

- **Combustible wastes**

Combustible wastes are all wastes that can contribute to a fire.

- **Storage**

- **Decay storage, short-term**

Storage of unconditioned residual materials or wastes with the objective of later release from regulatory control for conventional utilisation or disposal.

- **Decay storage, long-term**

Storage of wastes or residual materials with the objective of later release from regulatory control or later conditioning for final disposal.

- Allocation storage

Compilation of batches for a delivery for further treatment.

- Buffer storage

Storage of unconditioned wastes or intermediate products for a limited period of time prior to or during waste treatment.

- Interim storage

Longer-term storage of conditioned or partially conditioned wastes for later final disposal.

– **Product control**

Part of the general quality assurance during waste treatment and waste conditioning. It is based on regulations on quality assurance during registration and processing of radioactive wastes and during packaging of the wastes, as well as on the verification that the waste packages meet the requirements for final disposal and the development of a documentation /6/.

– **Product control measures**

- Plan of procedures

List of all relevant inspection and work steps and the necessary permissions for the conditioning of the waste packages with the objective of final disposal.

- Inspection plan

List of the inspection steps and permissions necessary for waste conditioning for interim storage.

- Procedure qualification

Qualification test performed by the Federal Office for Radiation Protection (BfS) for treatment and conditioning procedures, as well as quality assurance and documentation of wastes to verify that a conditioning procedure produces waste packages that meet the requirements for final disposal (Section 74 StrlSchV).

– **Residual material**

Material produced during handling of radioactive materials, as the case may be a material that can be reused without hazard.

– **Intermediate product**

Pretreated/treated radioactive waste that still has to be processed to a waste product.

2 Safety requirements

2.1 Enclosure of radioactive materials

The enclosure of radioactive materials has to be ensured by a system consisting of engineered barriers and complementary measures. For this purpose, several approaches can be used. So, for example, the stabilisation in a waste matrix, the enclosure in waste containers or, possibly, the barrier function of buildings and ventilation with retention devices can contribute to it. In general, the safe enclosure can be achieved technically, depending on the concept chosen, by one barrier or the interaction of more than one barrier.

The facilities for the interim storage of the low and intermediate level wastes and residual wastes are designed, among other things, for the handling and storage of enclosed radioactive materials, i. e. the waste containers fulfil the task of activity confinement. For a safe interim storage, this activity confinement has to be ensured during the entire storage period.

The scope of the administrative monitoring measures to be performed for the compliance with the protection goals during the interim storage at each waste package and in the storage room shall be as small as possible, taking into consideration the safety-related requirements. In view of the longer-term interim storage, the waste packages (waste container and waste product) shall be maintenance free. This results in several requirements on waste product and container which, in part, are more restrictive than the requirements for final disposal.

2.1.1 Waste products and packages

The requirements on waste products and on their chemical/physical form of the waste matrix are particularly determined by their behaviour during specified normal operation of interim storage facilities and repositories and in case of design-basis accidents. The waste matrix also performs, like the interim storage building and the waste container, functions for the retention of nuclides. A compilation of relevant waste characteristics

was first made for final disposal. The 14 safety-relevant characteristics for wastes and waste packages developed in this respect are as follows:

- Total activity of the waste package,
- activity of relevant single nuclides,
- dose rate at the package surface as well at distances of 1 and 2 m,
- surface contamination of the waste package,
- chemical composition of the raw waste,
- quality of the fixing agent,
- quality of a waste container,
- quantitative ratio: waste/fixing agent/water/aggregates,
- mixing (consistency),
- mass,
- setting condition of the matrix,
- water content and residual moisture,
- thermal behaviour, and
- stackability.

For wastes containing nuclear fuel, the fissile material content and the local distribution of the fissile materials in the waste volume shall be indicated. For wastes with non-negligible heat generation, the heat output has to be indicated.

Generally, these characteristics are also to be considered with regard to the longer-term interim storage. By means of conditioning of the radioactive wastes, intermediate or final products shall be produced which fulfil the requirements on safe handling, storage and transport also for the period of a longer-term interim storage. Within the frame of the procedure qualification performed by the BfS it can be demonstrated that the requirements on the longer-term interim storage of wastes, intended for later final disposal, have largely been fulfilled (see Section 74, para 2 StrlSchV).

For the longer-term interim storage, the waste products shall be chemically/physically sufficiently stable. This has to be ensured by adequate conditioning measures. Changes of the waste characteristics by digestion, fermentation or corrosion processes shall be minimised. Indications to such processes in the waste products are noticeable changes of the gas composition of the atmosphere inside the container.

Gas formation in waste packages is caused by chemical, physical and/or biological reactions. Thus, this gas formation is an indication of insufficient stability of the waste products and should therefore generally be limited to a scope which is possible with the procedures applied and which does not raise any safety concern. For this reason, adequate treatment procedures, such as drying of the wastes, are to be performed prior to the longer-term interim storage.

Due to the generation of chemically/physically stable waste products and their traceable documentation, defined characteristics of the waste product can be assumed also after a longer period of interim storage.

Therefore, the waste products, as e. g. compacted materials, can be handled with reasonable effort. Such a later handling after interim storage may take place, e. g., for the following reasons:

- Modification of the types of waste containers provided for final disposal,
- use of waste containers with low shielding due to the decay of radionuclides,
- sorting out of wastes and procedure for the release from regulatory control with the objective of non-hazardous reuse or conventional disposal.

For packages with wastes where major pressure build-up resulting from gas formation cannot be excluded also in case of proper conditioning, pressure relief measures are to be provided, as far as there are no requirements regarding the leak tightness of the waste containers. The assessment of the gas formation rate during interim storage shall be based on the state-of-the-art conditioning technology.¹

Regarding a longer-term interim storage, the compatibility between waste, fixing agent or waste matrix and container materials are of special importance.

In case of cement products those compositions are to be avoided which lead to shrinking of the product with gap formation between product and container wall or with formation of cracks in the product, or which lead to a volume increase of the product due to phase transformations up to the destruction of the waste container.

Reactions between waste product and the waste container, as it was observed in case of containers made of austenitic materials after filling with chloride-containing materials, are to be prevented by means of adequate conditioning. The same applies to a potential reaction between residues of organic solvents and the coating materials of the inner wall of the container.

Thus, regarding a longer-term interim storage, potential changes of the waste package characteristics due to reactions within the waste product or between waste product and waste container are to be considered in addition to the basic requirements and the above-mentioned waste characteristics relevant to final disposal for the assessment of waste characteristics for the period of interim storage.

In order to enable the documentation of the waste product characteristics in a traceable manner, the origin and characteristics of the raw wastes shall be determined and documented in a first step. Within the frame of the procedure qualification, the waste products to be produced then are to be assessed regarding their suitability for a longer-term interim storage on the basis of the available data. If for the longer-term interim storage only partial performance of treatment steps of the qualified conditioning procedure is provided, so the intermediate products are to be assessed regarding their suitability for interim storage.

Wastes with non-negligible heat generation shall be stable at the temperatures reached.

¹ So, e. g., compacted heterogeneously mixed wastes from operation and decommissioning of nuclear power plants mainly show gas formation rates below 2 ml/m³ h in standard condition (reference value for campaigns with compacted heterogeneously mixed wastes averaged over the waste products of a campaign).

2.1.2 Waste containers

As is the case for the waste products, the requirements on the waste containers are especially based on the safety analyses on specified normal operation and on the incidents at an interim storage facility and a repository. Further requirements may result, e. g., from the standardisation of waste containers. The requirements are laid down in the technical acceptance criteria of the interim storage facilities and in the final disposal requirements /5/. In addition, the requirements from the transport regulations are to be fulfilled in most cases. In individual cases, interim storage is performed in waste containers not qualified in accordance with the transport regulations, e. g. in case of an interim storage of wastes with higher dose rate in shielded storage areas. In these cases, the later consignment has to fulfil the requirements of the transport regulations by means of an additional outer packaging. The design of the waste containers has to be such that their handling can also be ensured during and after interim storage.

For a longer-term interim storage of the waste containers, long-term stability of the container materials has to be taken into consideration to fulfil the requirements over the storage period. The long-term integrity has to be ensured by means of an adequate design of the waste containers (material, dimensions, corrosion protection, and structural design, as e. g. avoidance of unprotected gaps). This design of the waste containers also has to take into consideration the physical, chemical and thermal properties of the waste product and the atmospheric conditions of the interim storage facility. Thus, the potential for any impairment of the container integrity caused by impacts from the interior of the container and from outside has to be considered.

Less stringent requirements may be applied to the design of the corrosion protection of the inner surface of the container in case of waste products with corrosion retardant properties, as e. g. dry combustion residues. The same applies to the design of the outer corrosion protection of waste containers for an interim storage in areas with dehumidified storage atmosphere.

As far as the waste containers are not suitable for a longer-term interim storage without any doubt due to their design (e. g. thick-walled concrete or cast iron containers) due to the properties of the content or due to the atmospheric conditions in the interim storage facility, recurrent controls of the waste containers by non-destructive tests, as e. g. visual inspections, shall be performed. To enable these controls, accessibility has to be ensured in the interim storage facility, e. g. by providing alleys between the package stacks or separate storage of packages that are representative for the stored packages as reference. The scope of the controls shall be defined individually in dependence on the design of the waste containers, the waste product characteristics and the atmospheric conditions in the interim storage facility.

2.1.3 Storage building

The waste packages fulfil, among others, the task of activity confinement. During specified normal operation, the only function of the storage building is the shielding against the environment and weather protection for the waste packages and the technical equipment of the storage facility.

Requirements on the design of the building for the control of incidents are described in Chapters 2.6 and 2.7.

A design of the building for the storage of wastes which may lead to emissions of radioactive substances is also admissible if the requirements stated in Chapter 2.1.1 are fulfilled. However, with regard to the emissions of radioactive substances with exhaust air and water, such a design necessitates additional technical efforts for a controlled air flow and recording of the emissions by measurements.

2.2 Criticality safety

As, in general, wastes with a criticality-relevant content of fissile materials are not stored at interim storage facilities, no special measures for criticality control are required. With regard to a future final disposal, the concentration and mass limitation of the thermally fissile nuclides U-233, U-235, Pu-239, and Pu-241 in the waste packages shall be oriented towards the plan approval decision for the Konrad repository /5/. If it is intended to store wastes with a higher content of fissile material or with mixtures of fissile materials and substances influencing the neutron balance, as e. g. graphite, an examination by the competent authority shall be performed in the individual case.

2.3 Radiation protection

2.3.1 Radiation protection concept

Pursuant to Section 6 StrlSchV /2/, any unnecessary radiation exposure or contamination of man and environment should be avoided. In addition, any radiation exposure or contamination of man and the environment shall be kept as low as practicable even where values are below the authorised limits, taking due account of the state of the art in science and technology and of the conditions of each individual case. Consequently, the scope of handling and monitoring measures performed by the staff in the storage area shall be kept as low as possible. From this protection goal, the requirements on the storage of radioactive wastes are derived. With regard to a radiation protection concept, there is the general requirement of a safe and maintenance-free longer-term interim storage of the radioactive wastes.

Pursuant to Section 34 StrlSchV /2/, a radiation protection instruction shall be developed for the operation of the facilities and technical equipment for the longer-term interim storage of radioactive wastes. This radiation protection instruction has to include the protection goals mentioned and the requirements and radiation protection measures derived from them. Further, the radiation protection instruction has to include the measures for the employees for ensuring the technical qualification in the field of radiation protection and for the promotion of a safety-oriented attitude and behaviour in accordance with the provisions of the Radiation Protection Ordinance.

For maintenance, control and repair work, corresponding equipment shall be available or procurable within an appropriate period of time. This shall be specified in the individual case. Planning and performance of this work shall be regulated in a procedure on work clearance under consideration of radiation protection aspects.

2.3.2 Shielding of ionising radiation

For the interim storage of low and intermediate level waste, the shielding of ionising radiation for the protection of the population (Section 46 StrlSchV) and the plant personnel (Section 43 StrlSchV) shall be ensured by the design of the waste containers and/or storage areas, storage concept and storage building.

For a member of the public, the maximum effective dose is determined at 1 millisievert in a calendar year. This limit value also applies to persons not exposed occupationally at the facility site and shall be observed as sum of the radiation exposure from direct and scattered radiation of the interim storage and inclusion of contributions to radiation exposure from emissions, direct and scattered radiation of all other nuclear facilities at the site. The stay time of a member of the public, which is relevant to the determination of the radiation exposure, depends on the conditions at the site. If there are no substantiated data for stay times, permanent stay shall be assumed.

For the operation of an interim storage facility, the dose rate values of the waste packages and components to be stored shall be such that the requirements of Sections 55 and 56 StrlSchV regarding the doses of an individual can safely be fulfilled.

For the demonstration of the necessary shielding of the waste containers and the storage facility or storage rooms by calculation of the radiation exposure in the environment and at the facility site, the gamma radiation has to be taken into consideration, including the scattered radiation and secondary radiation that occurs.

Regarding the placement and positioning of the waste packages in the storage facility, the mutual self-shielding effect of the waste packages shall be considered. When defining the positioning, aspects of accessibility and controllability of the waste packages shall also be taken into consideration.

An inadvertent removal of movable shieldings or unnecessary staying open of gates with shielding function shall be prevented.

The design of the storage building and particularly the design of ventilations ports, gates and expansion joints, the aspect of shielding shall be taken into account.

2.3.3 Radiation protection areas and operational radiation protection

Pursuant to Section 36 StrlSchV, the entire plant shall be divided into radiation protection areas and marked accordingly. In the radiation protection areas, the local dose and local dose rate shall be measured and documented in case of allocation changes and at regular intervals. These measurements are to be performed at representative points, measuring the gamma dose rate and, where appropriate, the neutron dose rate.

Pursuant to Section 39 StrlSchV, the room air in the work areas where contamination may occur shall be monitored at regular intervals, e. g. by mobile air samplers. For the storage of packages with significant inventories of H-3 and C-14, the potential emissions shall be assessed regarding compliance with the requirements of the Radiation Protection Ordinance and, where necessary, room area monitoring measures shall be provided.

Work places and objects shall be checked whether they are free of contamination in an appropriate manner and the results are to be documented (Section 44 StrlSchV). For decontamination, the organisational proceeding shall be specified and adequate means be provided or be procurable in the short term.

The body dose of occupationally exposed persons in controlled areas shall be determined for gamma radiation and, where necessary, neutron radiation, by means of adequate official dosimeters and documented (Sections 40, 41, 42 StrlSchV). Regarding work performed at the interim storage facilities, dosimeters whose results can be read at any time and that comply with the state of the art shall be used in addition to the official dosimeters. Regarding the work places, protection of the personnel against external and internal radiation exposure shall be ensured primarily by technical measures (Section 43 StrlSchV).

Pursuant to Section 67 StrlSchV, the radiation measuring devices used and kept available shall comply with the requirements of the measurement purpose, checked for their functional performance and maintained at regular intervals. The measuring devices shall be available in sufficient numbers.

2.3.4 Radiation protection of the environment

At interim storage facilities, the local dose shall be measured at representative points, e. g. at the site fence, regarding compliance with the limit values as stipulated in Section 46 StrlSchV. The Guideline Relating to Emission and Immission Monitoring of Nuclear Facilities (REI) /11/ shall be applied to facilities licensed according to the Atomic Energy Act and facilities with licences according to the Radiation Protection Ordinance analogously for the dose measurement.

More extensive monitoring measures shall be provided if discharge of radioactive substances during specified normal operation (Section 47 StrlSchV) has to be postulated. If the retention capability of the waste containers regarding the volatile radioactive materials (e. g. H-3 und C-14) cannot be ensured, the emissions resulting from it shall be determined and assessed for compliance with the limit values of Section 47 StrlSchV.

2.4 Structural requirements for new storage buildings

Buildings shall be erected according to the building regulations of the *Länder* and the generally accepted engineering standards. In addition, further design requirements result from the safety analyses on specified normal operation of the interim storage facility over a period of up to 40 years and on incidents:

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- For the design of the building, the life cycle provided shall be considered with regard to the durability and functional performance of the building materials.
 - The floor in the storage area shall have an adequate compressive strength and wear resistance.
 - The bottom plate of the storage facility shall be designed for carrying transport vehicles and for the container loads according to the number of waste packages to be stored and their allocation. In this respect, partial allocation conditions also shall be considered.
 - For the structural design, load impacts during transport processes also shall be considered, where applicable. Further, the crane loads and loads of other heavy elements, e. g. shieldings, and special loads from internal and external impacts shall be taken into consideration.
 - With the exception of decontaminable coatings, the materials used for the building with reception and storage area shall be “inflammable” (Class A according to DIN 4102, Part 1 /7/, KTA 2101) (see Chapter 2.5.4).
 - The building shall be equipped with earthing and lightning protection systems in accordance with the conventional rules and regulations. More stringent requirements only shall be considered if monitoring and protection functions may be affected.
 - The design of the storage building shall be such as to ensure stability for the load case fire according to DIN 4102, Part 2 to 4 /7/.
 - The top edge of the floor has to be above the water level for the 100-year flood and other structural measures are to be provided against the intrusion of water. Temporarily measures are to be provided for the 10 000-year flood.
 - The control of the impacts defined in Chapter 2.6 and 2.7 has to be verified.

2.5 Technical equipment

2.5.1 Hoisting equipment and other transport devices

Hoisting equipment used for the handling of wastes shall be designed in accordance with the general accident prevention regulations. The design of the hoisting equipment and devices shall be such that the waste packages stored can also be safely handled in case of longer-term interim storage. For this purpose, maintenance work and tests shall be performed at regular intervals. If the hoisting equipment and transport devices cannot be used over a longer period of time, these regular measures can be replaced by tests prior to return to service. The maintenance and test intervals shall be adjusted to the utilisation and the necessary operational readiness.

Also after emplacement it shall be ensured that all necessary hoisting equipment and transport devices are available on site or can be procured in the short term for utilisation.

2.5.2 Room air conditioning

For the longer-term interim storage of sheet steel containers without additional corrosion protection measures and wastes without hermetic isolation from the hall atmosphere, sufficient limitation of the relative humidity of the room air shall be ensured. For this purpose, a room air conditioning of the storage hall may be necessary. In this respect, dehumidifiers or (underfloor-) heating systems may be used. If required, measures shall be taken which enable sufficient ventilation of the waste package stacks at floor level. For this purpose, the waste packages can be placed, e. g., on grids.

2.5.3 Electrotechnical equipment

The electrotechnical equipment shall be designed for the storage period intended if they are only accessible with considerable radiation protection efforts due to the wastes stored there. The maintenance and test intervals shall be adjusted to the utilisation and the necessary operational readiness.

2.5.4 Fire protection and fire protection equipment, explosion protection

For the entire storage period envisaged, measures shall be established for the prevention of fire loads and ignition sources, for early detection and for effective fire fighting. If formation of explosive gas mixtures has to be postulated resulting from releases the wastes stored, adequate preventive measures shall be implemented.

The long-term integrity of the waste containers stored shall also be ensured with regard to fire protection, since a loss of integrity may also lead to an increase of the fire load in the storage room.

2.6 Internal impacts

Regarding the protection against safety-relevant events at interim storage facilities (Section 49 StrlSchV) and other facilities and installations (Section 50 StrlSchV), the planning of structural or other technical protection measures against incidents shall include measures for the limitation of releases of radioactive materials into the environment. For interim storage facilities at nuclear power plants (licensed pursuant to Section 7, para 1 AtG), these measures shall be based on the planning values of Section 49 StrlSchV, for other waste interim storage facilities (licensed pursuant to Section 7 StrlSchV or, in case of decommissioning, Section 7, para 3 AtG) the requirements of Section 50 StrlSchV shall be applied. Type and scope of protection measures under consideration of the individual case (hazard potential of the plant/facility, occurrence probability of an

incident) and the protection objectives shall be defined in a general administrative provision (AVV) on Section 50 StrlSchV which is still to be developed. Detailed requirements for the mitigation of the consequences of incidents or accidents for the interim storage facilities concerned are therefore not defined in these safety requirements.

In both cases (Section 49 and Section 50 StrlSchV) it shall be determined in an accident analyses which operational disturbances and incidents may occur in connection with the storage of low and intermediate level wastes. For this purpose, the conditions of storage, including potential long-term effects and impacts from other facilities at the site, as well as operating procedures shall be analysed systematically and experiences from comparable facilities shall be taken into consideration.

On the basis of this analysis, the design-basis accidents for storage shall be derived and differentiated from operational disturbance belonging to abnormal operation and residual risk events. Human errors shall be considered in the analysis of the incident and accident possibilities or activity release. For design-basis accidents, compliance with the requirements of Sections 49 and 50 StrlSchV shall be verified by calculation of the potential radiological consequences, as far as these possibilities cannot be excluded due to the precautions that have provably been taken.

Regarding the storage of low and intermediate level waste, the following plant-internal events shall be considered as design-basis accidents:

Mechanical impacts, such as

- drop of a waste package or a component from the maximum height to be considered in the most unfavourable impact position, and
- drop down of the largest load to be considered onto the waste packages.

Fire

The maximum stationary and temporary fire loads in the storage rooms shall be considered. In addition to the demonstration of the retention capacity of the waste packages to be performed, potential fires at the facility with potential activity release are to be analysed. The release of radioactive substances from the waste packages depends on fire duration and temperature.

Even if the waste container itself is inflammable, a release of radionuclides may occur in case of fire impacts. The release mechanisms pyrolysis, evaporation and sublimation shall also be taken into consideration. The limitation of the maximum activity inventory of the radioactive wastes store shall be considered when analysing the release of radioactive materials into the environment.

Wastes in thick-walled cast iron containers do not contribute to the fire load. Further, wastes in concrete containers can be classified as inflammable. Here, it is irrelevant if the waste drums contained are encapsulated in concrete or not.

Radioactive wastes in other containers shall be classified as inflammable for the consideration of incidents and accidents if all other prerequisites are met:

- The radioactive wastes are stored in closed containers, such as sheet steel containers.
- There are no self-igniting or explosive substances in the radioactive waste packages.
- In the storage area, there are no materials which may lead to a release of heat to an extent which might impair the integrity and tightness of the waste packages stored.

Failures of safety-relevant systems and equipment

Events shall be taken into consideration, such as

- failure of the electricity supply,
 - failure of I&C equipment, and
 - failure of hoisting equipment and transport devices.
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2.7 External events

For the interim storage of low and intermediate level waste, the following external events generally shall be included in the analysis of the potential consequences:

- Natural external events, e. g. storm, rain, snowfall, freeze, lightning, flood, forest fires, earthquakes, landslide.
- Man-induced external events, e. g. impacts of harmful substances, blast waves caused by chemical reactions, external fire spreading to the interior, damages by mining, aircraft crash.

Site-specific conditions shall be considered in addition, where necessary.

Possible interactions with neighbouring nuclear facilities are dealt with in Chapter 2.8. External impacts due to deliberate interference by third parties are considered within the frame of measures taken against disturbances and other interference by third parties and not further addressed here.

2.7.1 Natural external events

The load assumptions for natural events shall be defined according to the site-specific conditions.

- The storage building shall be protected against lightning according to the relevant VDE guidelines and conditions (also see Chapter 2.4).
- The storage facility should be located at a flood-free site. If flooding cannot be excluded, the storage building must be protected against the intrusion of water by adequate measures (see Chapter 2.4).
- For the determination of the type of the seismic design of an interim storage facility it shall be examined site-specifically whether due to postulated damages caused by earthquake - e. g. collapse of the storage building, drop of heavy loads, drop down or topple over of waste packages or fire - the radiation exposure resulting from the release of radioactive materials into the environment might exceed the planning value of 50 mSv (effective dose). If this is the case, the components of the interim storage facility are to be classified and designed against earthquake according to KTA Safety Standard 2201, applied analogously.

2.7.2 Man-induced external events

The load assumptions for man-induced external events are determined according to the state of the art in science and technology under consideration of site-specific conditions. Within the frame of an accident analysis, it shall be demonstrated which consequences are to be expected from man-induced external events. The decision which events shall be classified as design-basis accidents as defined in the Radiation Protection

Ordinance and for which events only protection measures are necessary under the aspect of minimisation of damage extent, shall be oriented towards the occurrence probability and the impacts of the events.

Aircraft crash, blast wave and ingress of toxic substances are, in general, beyond-design-basis accidents. In this respect, damage reduction measures in case of an aircraft crash and blast waves with impact from outside can be considered on the basis of the load assumptions from RSK guidelines for pressurised water reactors for aircraft crash /16/ and the guideline of the Federal Ministry of the Interior (BMI) on the protection of NPPs against blast waves /4/ and the emplaced radionuclide inventories. The aspect of damage extent reduction has been adequately taken into account if also in case of these events the radiological consequences determined under realistic boundary conditions do not necessitate decisive accident management measures (see Section 7, para. 2a AtG). The reduction of the consequences in case of aircraft crash and blast waves may either be achieved by the waste containers/packages or by a combination of waste containers/packages and storage building.

2.8 Interaction with existing nuclear installations

As far as further nuclear installations at the site of the interim storage facility contribute to the radiation exposure of the population, these installations shall be considered regarding the prior radiation exposure. The limit value for radiation exposure of members of the public shall not be exceeded according to Section 46 para 3 StrlSchV, also taking into consideration direct and scattered radiation and the emissions from nuclear installations.

3 Quality assurance and product control

The task of product control of radioactive wastes is, on the one hand, to ensure within the frame of procedure qualification prior to the actual work that the wastes demonstrably meet the requirements for final disposal or interim storage. This requires organisational and administrative regulations which define the areas of responsibility, tasks and activities of the persons involved. On the other hand, the fulfilment of the requirements mentioned is demonstrated during the performance of work and the proper performance of the licensed procedures is documented. Provisions on the performance of the product control with regard to final disposal have been established on the basis of the Radiation Protection Ordinance, the requirements for final disposal and the decision of the Bund-Länderausschuss (*committee of the Federal Government and the Länder*) of December 1994. Those involved in product control are the supervisory authorities of the waste producers and of the interim storage facilities, the Federal Office for Radiation Protection (BfS), the experts consulted by these authorities, the waste producers and their service providers as well as the operators of the interim storage facilities.

Type and scope of the measures related to product control are defined by the competent authorities depending on the conditioning procedure, the waste characteristics and the requirements of the intended interim storage facility and the repository.

A flow chart on product control with relevant explanations according to the decision of the Bund-Länderausschuss of December 1994 is presented in the Annex of these safety requirements. This procedure is generally practised for the majority of waste producers. For the longer-term interim storage, this procedure shall further be applied analogously.

The measures for product control are defined by the procedure qualification of the Federal Office for Radiation Protection (BfS) and, where applicable, also by a campaign approval of the nuclear supervisory authority. This procedure qualification may be performed, according to the application submitted, as campaign-dependent or campaign-independent procedure qualification.

3.1 Procedure qualification

For the qualification of conditioning procedures, the measures of the waste producers, the transport companies, the conditioners and the operators of interim storage facilities shall be examined under consideration of assessments, accompanying controls and inspections by independent experts according to the instructions of the competent authorities.

According to the requirements on product control for the Konrad mine (/8/ und /5/), the individual work and inspection processes for a campaign-independent procedure qualification shall be described by the applicant in a manual. In general, the applicant applies for a campaign-dependent procedure qualification and submits a plan of procedures. Since its introduction in 1988, this approach has generally proven successful also for interim storage. Experience showed that the fulfilment of the requirements from final disposal, interim storage and the supervision procedures for waste campaigns can be ensured by such a campaign-dependent procedure qualification.

Within the frame of the procedure qualification, the entire conditioning procedure, from listing of the raw wastes up to verification that the wastes meet the requirements for final disposal, shall be submitted to the BfS or the supervisory authority, respectively. An interruption of waste treatment for longer-term interim storage of partly treated wastes is permissible in case of steps reasonable from an engineering point of view. This interruption shall be specified within the frame of campaign application and procedure qualification, and the acceptability from a safety point of view shall be substantiated.

3.2 Qualification of the waste containers

Specifications on the qualification of the waste containers are laid down by the transport regulations, the product control regulations on the final disposal conditions (/8/ und /5/) and the respective acceptance criteria for the interim storage facilities.

The compliance with the requirements for waste containers and packages shall generally be ensured by type tests and accompanying manufacturing controls. The qualification and acceptance of the waste containers shall be confirmed by the authorities competent for interim storage and final disposal. As far as the requirements from the traffic law cover the requirements from the interim storage and final disposal, proofs according to the traffic law may be sufficient.

Specifications on the performance of inspections by plant specialists and on performance and review of quality-assuring measures and controls during manufacturing, filling and storage of the waste containers are laid down in the product control regulations on the final disposal conditions (/8/ und /5/) and shall be adopted in the acceptance conditions of the respective interim storage facility.

The permission for the use of the respective packagings is issued by the competent authorities.

3.3 Documentation

The documentation on storage at an interim storage facility shall include the relevant data on the waste packages and origin of the wastes, also for the purpose of final disposal or later release from regulatory control. Specifications on the data to be documented are laid down in Annex X of the Radiation Protection Ordinance /2/. Data on structure and contents of the waste package documentation are exemplary given in the technical acceptance criteria for the interim storage facility Gorleben /15/ and in the requirements on product control for the Konrad mine (/8/ und /5/).

The documentation of the waste packages for interim storage shall be structured following the existing requirements for final disposal and shall include all data required for the documentation necessary for later final disposal or release from regulatory control. Thus, in addition to the fulfilment of the requirements of the final disposal conditions currently existing, all other data on waste origin, waste flow, conditioning procedures and packaging shall also be acquired and documented to generally enable a supplementary declaration of repository-relevant characteristics without additional measurements. On the basis of the data on the raw wastes, on processing and packaging, data shall be submitted on the material composition of the waste packages to be stored.

The scope of declaration of radionuclides and material constituents is oriented towards the respective most stringent requirement of the final disposal conditions for the Konrad mine /5/ or the site-independent final disposal conditions /10/, respectively.

In addition to the acquisition of the known data of the waste packages and for the demonstration of product control measures, the documentation shall include proofs on the fulfilment of the requirements of interim storage. These may be, for example, further data on radionuclides with higher volatility or additional proofs on the permission to use the respective packagings.

The waste package documentation may be performed for each package or together for several packages of one conditioning campaign. In this respect, at least the issues stated below should be documented as follows

- Data sheet with data on waste product group, waste container classification, compliance with limit values, radionuclide inventories and material composition,
- records on procedure qualification performed and approval of conditioning campaign,
- records on the accompanying control performed by experts on site,
- records on the review of the documentation and statements of the competent authorities (to be completed after review and statement),
- description of raw waste origin and composition,
- description of the conditioning process, e. g. by means of acquisition of operational data, including deviations occurred and special occurrences as well as the accompanying controls performed,
- compilation of the analysis and measurement data (activity, gas and material analyses, dose rates, contaminations),
- description of activity calculation/activity determination, calculation and declaration of the activities of the repository-relevant radionuclides and the overall inventory,
- description of the waste containers with data on approval and on type tests performed, proof on long-term stability/corrosion resistance for steel sheet (drums, containers), and
- documents on the origin (e. g. drum lists, transport documents, reception reports of the conditioning facility, etc.).

For the longer-term interim storage of wastes not yet conditioned to meet the requirements for final disposal, such as major components not disassembled, the documentation shall be prepared analogously under consideration of the respective requirements laid down in the storage licence.

For the development of a waste package documentation, general documentation quality requirements regarding clearness and completeness shall be observed. The access to the documents and their readability shall be ensured for the entire period of longer-term interim storage up to disposal in a repository or release

from regulatory control according to Section 29 StrlSchV. In this respect, KTA 1404, Annex B /12/ may be followed regarding the general documentation requirements. Retention periods otherwise specified shall be at least adjusted to the interim storage period envisaged.

3.4 Old wastes

Old wastes are already existing waste products or waste packages not produced according to a qualified procedure. This term is particularly applied to wastes with inadequate documentation compared to today's standards. For these wastes, measures shall be taken which ensure compliance with the protection goals of interim storage and enable later compliance with requirements of a repository without additional efforts on characterisation. Thus, these old wastes can generally be considered like newly produced raw wastes.

A post qualification of the old waste packages shall be performed firstly by a document research and, where necessary, additional investigations. The available documentations on the wastes are reviewed and the existing knowledge is compiled and evaluated. The subsequent examinations of the wastes performed if necessary aim at filling in the documentation gaps identified. These post qualification campaigns shall be applied for at the competent authority for product control, as is the case for conditioning campaigns for newly produced wastes. Within the frame of a qualification campaign, the existing waste package documentation shall be submitted to the competent *Länder* and federal authorities together with a plan of procedures.

The measures for the post qualification of the existing old wastes shall be taken as soon as possible. If it cannot be verified by the research that the existing waste products and waste packages meet the requirements for a longer-term storage, post examination and, where necessary, post conditioning campaigns shall be planned and performed without any delay. Deficiencies of waste packages identified during the post qualification shall be eliminated by qualified treatment procedures

If this research only results in documentation gaps, the post qualification of old wastes may be performed in dependence on the conditions of the interim storage facility by examinations with the aim to fill in the gaps in the package documentation for later disposal.

4 Operation of the interim storage facilities

The safety requirements primarily aim at the longer-term operation of the currently existing interim storage facilities for which it was not foreseeable at the time when licence was granted that the storage period of the wastes can extend over several decades. This long storage period may, among other things, have an effect on the organisation of the storage facility operation. However, the safety-related principles of the safety requirements shall also be applied to storage facilities to be built. It therefore will be mentioned in the following if individual provisions exclusively refer to facilities to be built.

Further, distinction is to be made according to storage concept, i. e. according to the respective contribution of the waste product, waste container, waste package and storage building to the fulfilment of the safety requirements. Further distinctions may result with regard to the spectrum of the wastes stored.

4.1 Operation principles

The construction and operation of the interim storage facility shall be performed in such a manner that the necessary precautions are taken according to the state of the art in science and technology. In this respect, the following operation states shall be considered in particular:

- In case of newly constructed storage facilities: all processes for reaching normal operating conditions of the facility for the first time (commissioning),
- specified normal operation,
- detection and control of disturbances and incidents, as well as elimination of their consequences, and
- early identification of adverse changes of the retention properties of the waste product, the waste package and the storage building.

For the safe performance of the operational processes, the entire operation shall be structured in an adequate manner. For this purpose, the following requirements shall be complied with:

- All operational process shall be clearly described.
- All systems and equipment necessary for safe performance of operation shall be specified.
- Persons with performance authorisation shall be assigned to the operational processes.

In particular, the necessary personnel, organisational and safety-related administrative prerequisites shall be established and demonstrated. For the operational processes as well as the control of incidents and elimination of their consequences, clear instructions shall be laid down in an operating manual. Competencies and responsibilities shall clearly be specified.

4.2 Commissioning of newly constructed storage facilities

Before operation of the storage facility, all systems and equipment of the facility shall be subjected to commissioning tests. These tests shall be specified in a commissioning programme. They serve to verify that the systems and equipment of the facility were installed so as to meet the requirements of planned operation.

Prior to first emplacement of wastes, the entire handling procedure, including protection measures, shall be tested. During this trial run, procedure deficiencies, that might still exist, are identified, handling of waste

packages is optimised, and the planned procedures adapted and finally stipulated. Prior to the first emplacement of a new package type, inactive testing shall be performed.

4.3 Operation

An operating manual shall be developed in analogous application of KTA 1201 /13/ which describes all operational processes and measures to be taken in the case of incidents in form of clear operating instructions. In particular, all aspects related to safety shall be addressed. In addition, the proceeding in case of modifications or supplementation of parts of the facility and procedures shall be laid down. This shall serve to ensure that the personnel can initiate and perform the necessary measures during operational processes or in case of incidents without any delay and in a reliable manner. Further, it shall be ensured that by the review of the predefined instructions potential side impacts of an action are examined and, where necessary, are prevented or limited by the choice of the proceeding or by additional instructions. Analogously, it may be prevented by an examination of proceeding modifications and supplementations of parts of the facility that unwanted impacts on operation and safety aspects occur.

Prior to each emplacement of wastes, these are subjected to a receiving inspection (also see Section 75, para 3 StrlSchV). The receiving inspection serves the purpose of verification and shall enable the following:

- Identification control: determination whether the wastes agree with the wastes declared for reception.
- Compliance with acceptance criteria: verification that the acceptance criteria defined in the licence have been met. For this purpose, quality-assured data of the conditioner may also be referred to.
- Verification of the data of the deliverer: determination of certain specific characteristics of the waste, independent of the data of the deliverer. Specific characteristics may be, for example, mass, dose rate and surface contamination.

As far as emplacement of the wastes from a neighbouring facility of the same operator is performed without using public transportation routes, certain parts of the controls, which were already performed at the neighbouring facility, may be dispensed with within the frame of the receiving inspections of the interim storage facility.

For the emplacement operation, to be regulated in an instruction or provision, the following shall be controlled:

- Mass, dose rate and surface contamination of the waste unit (by spot checks),
- condition and declaration of the waste unit, and
- agreement with the declared data.

Further, the following shall be observed:

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- In case of non-compliance, extended controls shall be performed.
 - The receiving inspections shall only be performed by trained personnel.
 - Disturbances and deviations at packages detected during a receiving inspection shall be reported to the supervisory authority immediately. For this purpose, a reporting scheme shall be established.

Records shall be prepared on the emplacement

If wastes shall be removed from storage at the facility, the necessary proofs on compliance with traffic law provisions shall be delivered in case of intended transport on public roads. For removal from storage at the facility, exit inspections shall be performed. The outgoing packages shall be identified and declared without ambiguity. Records shall also be prepared on the removal from storage at the facility.

If it has to be assumed for the longer-term interim storage that the retention properties of the waste packages are subject to a relevant change in the course of time, measures shall be taken for an early detection of adverse developments. These may be, depending on storage and package type, as follows:

- Emplacement of the waste packages in the storage facility may be performed such that these are made accessible directly, when required, and may be subjected to visual examinations and inspections.
- The visual examinations and inspections are performed on reference packages. On the basis of the condition of these reference packages, conclusions are drawn on the condition of the other waste package. This proceeding requires that the reference packages are stored under representative conditions with regard to potential degradations of their retention properties.

Reference packages shall be preferred particularly when visual examinations and inspections directly on the waste package would lead to relevant radiation exposure due to a high local dose rate.

The assumptions and boundary conditions for the package properties and relevant waste characteristics used in the safety analyses, especially the limitations of the dose rates and the radionuclide inventory, shall be included in acceptance criteria for the interim storage facility. For the verification that the acceptance criteria are complied with, implementation provisions shall be defined. This also includes work instructions and examination procedures to be considered for the handling of the packages.

For safety-relevant systems and devices of the storage facility, as e. g.

- hoisting equipment,
 - alarm systems,
 - radiation protection systems, and,
 - where necessary, ventilation and I&C systems,
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recurrent tests shall be performed. Their frequency shall be defined according to the safety significance of the components to be tested under consideration of the specific regulations. Typical test cycles are annually or bi-annually. The recurrent tests shall be defined in a testing manual in analogous application of KTA 1202 /14/. The results of the recurrent tests are documented (see Chapter 3.3) and available for long-term monitoring (see Chapter 4.7).

The operation of the plant shall be monitored to identify safety-relevant operational disturbances and incidents in a reliable manner and the countermeasures laid down in the operating manual can be taken. Fault alarms shall be recorded centrally and, if required, forwarded and documented.

Safety-relevant events during commissioning, specified normal operation (in particular during maintenance and inspection) and recurrent tests shall be documented. The consequences derived from the evaluation of such events shall be assessed and, where appropriate, included in the plant operating rules.

Type and scope of this documentation shall be defined in analogous application of KTA 1404 /12/, Chapter 9. According to Annex B of this KTA standard, the documentation shall be archived safely for a long period of time.

Experiences from operation of comparable facilities shall be taken into consideration for the operation of the interim storage facility. This ensures that experiences are analysed and assessed for their transferability particularly with regard to

- the long-term material behaviour of the packings,
- observations on slow changes of the waste product, and
- ageing phenomena of storage equipment.

In this manner, very slow processes and rare events or only occurring in connection with certain wastes can be adequately considered in the operational management. In this respect, procedures shall be provided which ensure experience exchange (e. g. on the basis of operating reports) between the operators of interim storage facilities at regular intervals.

The technical equipment used for the handling of the packages and their transport shall be available as long as all packages have been removed from the storage facility. In this respect, it shall be assumed that a transport of the packages, e. g. for emplacement in a repository, may take place over a longer period of time. For this purpose,

- the necessary systems and devices of the storage facility (e. g. hoisting equipment) may either be kept operable or in such a condition that the operability can be restored (e. g. by a recurrent test) in the short term,
 - the auxiliary means necessary for transport (e. g. overpacks, special loading devices) shall be kept available,
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- the packages shall be maintained in a condition which generally enable the fulfilment according to traffic law, and
 - those means being required for obtaining a licence according to transport law (e. g. measuring and test devices, documentation) shall be kept available.

4.4 Maintenance

For maintenance, distinction shall be made between the types of storage facility equipment and wastes stored.

For new storage facilities to be constructed, those facility systems and devices which require the performance of tests or maintenance work shall be positioned for easy access or made accessible by technical devices. The spatial conditions shall be such that there is sufficient space for maintenance work, keeping available additional shieldings which might be necessary for reasons of radiation protection. For the preparation and performance of maintenance work, respective procedures shall be included in the operating manual.

Due to the long storage periods of packages it cannot be excluded that for some waste packages repair or post treatment will be required. If damages at waste packages are detected, and if these have a relevant impact on the activity confinement, or if limitations regarding handleability or compliance with requirements of fire protection cannot be excluded, the waste packages shall be subjected to a treatment. In order to enable corresponding realisation when required, devices and measures shall be kept available in the short term. So, for example, overpacks for the transport of the waste packages shall be kept available or it shall be ensured in another way that these shall be made available for the stored package types to the necessary extent if required. For these repairs, a repair concept shall be developed where it is described in which way and in which facilities defective packages are repaired.

4.5 Personnel

Irrespective of the situation on site, the storage facility shall be staffed with qualified personnel in sufficient numbers who meet the requirements of safety and is trained regularly. This also applies especially if the personnel are only used in case of demand or temporarily. In this respect, distinction shall be made between the following cases:

- Storage facilities belonging to a nuclear installation in operation or being dismantled: Here, personnel of the nuclear installation are used for the majority of the tasks.
 - Storage facilities permanently staffed with own personnel: These facilities shall be considered self-sufficient with regard to operation.
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- Storage facilities not requiring permanent staffing: Here, the functions are limited to the use of personnel in case of demand for emplacement or retrieval campaigns or regular inspections. The demand is temporarily and is mostly covered by personnel mainly fulfilling other tasks.

For the operation of the storage facility, teams shall be established who work together as regular as possible, practising an intensive exchange of experiences and also conduct tests (see Chapter 4.2) and the respective evaluations. These staff members shall fulfil this task on a continuing basis. This particularly applies to personnel fulfilling the tasks only in case of demand.

The technical qualification required in dependence on the respective position shall be verified according to the requirements of the Radiation Protection Ordinance or special provisions, respectively. The requirements regarding the responsibility in issues related to nuclear safety are regulated by the Atomic Energy Act and the Radiation Protection Ordinance. The competencies and deputy regulations are clearly laid down in the operating manual of the interim storage facility.

Attention shall be paid to the development and promotion of a high safety culture. This also applies in particular to facilities where personnel have to take actions relatively seldom or such where alternating personnel are used according to the different tasks. Regarding the longer-term operation of the storage facilities, it shall be assumed that personnel changes will be necessary. In this respect, it shall be ensured that the human resources necessary for the maintenance of a sustainable safety culture remain available. This requires a long-term and careful planning on personnel deployment and on the maintenance of expert knowledge and experiences.

4.6 Emergency preparedness

Depending on storage type and the wastes stored, different emergency preparedness measures may be necessary (see Sections 50-53 StrlSchV). In case of storage facilities exceeding the activity limitations specified in Section 53 StrlSchV, a plan for accident management measures shall be developed on the basis of the potential releases of radioactive materials from the storage facility and, where required, be harmonised with the accident management plan of the neighbouring nuclear installations and agreed upon with the competent authorities. Copies of the accident management plan shall be kept available at any time at a permanently staffed location. Further copies are submitted, if required, to the neighbouring facilities, the competent authorities and security organs.

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

For a longer-term operation of storage facilities, effects shall also be taken into consideration which develop very slowly and only lead to noticeable changes in the course of years or decades. Examples for such effects are anaerobic corrosion at container walls, gas formation due to slow microbial processes or the ageing of buildings.

For this reason, a monitoring concept shall be developed for the identification and management of long-term and ageing effects during the operation of the storage facility. The monitoring concept shall be submitted to the licensing authority in case of storage facilities to be constructed and to the supervisory authority in case of existing storage facilities.

In this respect, distinction regarding the storage facility equipment shall generally be made between components and parts designed for the entire life of the storage facility and those that may be replaced, if required. One of the components and parts designed for the entire life of the storage facility is, in particular, the building. The concept on long-term monitoring and maintenance of the building shall cover all adverse changes that may influence the operability of the necessary equipment (e. g. cranes and hoisting equipment, movable gates) and the long-term stability of the packages (e. g. ingress of moisture).

The properties and functions of the systems, components and parts of the storage facility necessary from a safety perspective shall be ensured during the whole operational life. In particular, the transport of the waste packages within the storage facility or site and the removal from the site for external treatment shall be realisable under consideration of the site-specific conditions.

With regard to components and parts that may require replacement, attention shall be paid to adequate accessibility and that the work can be performed without major interference with facility operation and preferably shielded from the radiation field of the waste packages.

As far as the waste packages make a relevant contribution to activity retention, the monitoring concept shall cover the long-term and ageing effects of wastes and waste packages and shall be differentiated according to all waste and packages types. In this respect, the following information sources shall particularly be referred to:

- Results of inspections or special examinations on packages,
- inspections or special examinations on reference containers,
- evaluation of operating experience from the own facility and other facilities, and
- findings on material changes (waste, waste containers, interaction between waste and conditioning material, knowledge on package material, etc.).

At intervals of ten years, the operator of the storage facility shall regularly prepare a report on the condition of the storage building, the components necessary for storage and handling, and the waste packages. This report shall particularly include the experiences from recurrent inspections, operating experiences and the implementation of the monitoring and maintenance concept. For this purpose, a walk-down by experts shall also be performed. Should this not be possible for concept-related reasons, or if this would lead to excessive radiation exposure of the personnel due to the radiation field, adequate alternative measures shall be provided (e. g. use of mobile or stationary cameras). For storage buildings with relevant loads, recurrent settlement measurements shall be performed additionally and evaluated with regard to long-term adverse changes.

Furthermore, the report shall include a prognosis on the storage life of the package and waste types on the basis of the observations made during package tests and the observations made during walk-down of the storage facility.

5 Regulations, guidelines and standards

- /1/ Act on the Peaceful Utilization of Atomic Energy and the Protection against its Hazards (Atomic Energy Act - AtG) of December 23, as Amended and Promulgated on July 15, 1985 (Federal Law Gazette, Part I, page 1565), Last Amended by the Act of July 27, 2001 (Federal Law Gazette, Part I, page 1950, 2010)

 - /2/ Ordinance on the Protection against Damage and Injuries Caused by Ionising Radiation (Radiation Protection Ordinance - StrlSchV) of July 20, 2001 (Federal Law Gazette, Part I, page 1714) (Federal Law Gazette, Part III, 751-1-8)

 - /3/ DIN 25401-9
Begriffe der Kerntechnik, Teil 9, Entsorgung
Nuclear Terms, Part 9, Disposal
Beuth-Verlag, Berlin, April 2002

 - /4/ BMI
Guideline for the Protection of Nuclear Power Plants against Pressure Waves from Chemical Reactions by Means of the Design of Nuclear Power Plants (August 1976), Federal Bulletin No. 179 of September 22, 1976

 - /5/ Niedersächsisches Umweltministerium
Planfeststellungsbeschluss für das Endlager Schacht Konrad
Plan Approval Decision for the Konrad Repository
Published in the Lower Saxony Ministerial Gazette on June 12, 2002

 - /6/ International Atomic Energy Agency
Quality Assurance for Radioactive Waste Packages
Technical Reports Series No. 376
IAEA, Vienna, 1995

 - /7/ DIN 4102, Parts 1 to 4
Brandverhalten von Baustoffen und Bauteilen
Fire behaviour of building materials and components
(Part 1: as Amended in 05/98; Part 2: as Amended in 09/77; Part 3: as Amended in 09/77; Part 4: as Amended in 03/94, Last Amended in 09/98)
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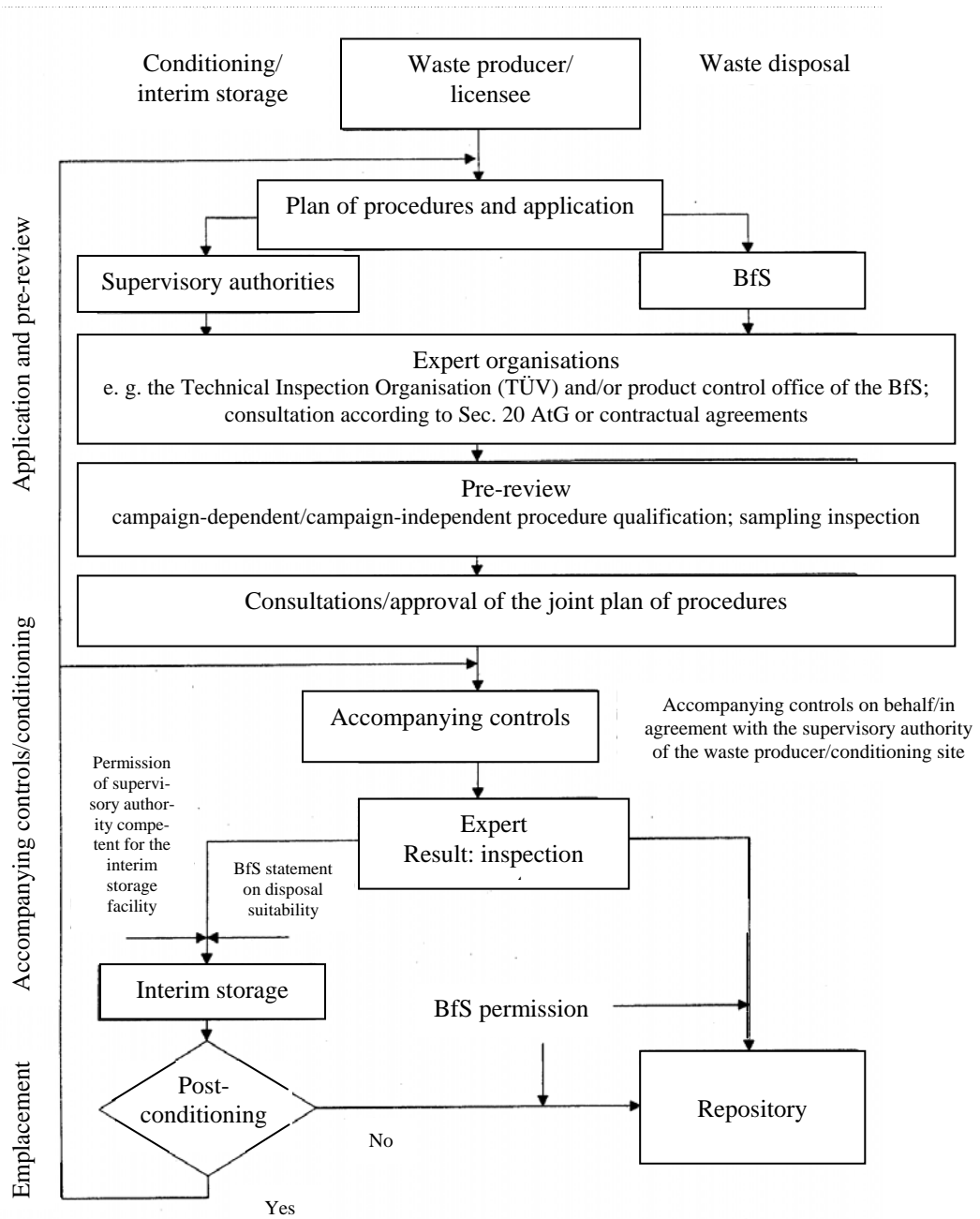
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- /8/ Federal Office for Radiation Protection (BfS)
Produktkontrolle radioaktiver Abfälle, Schachtanlage Konrad
Product Control of Radioactive Wastes, Konrad Mine
December 1995
Salzgitter, December 1995, ET-IB-45- REV– 3
- /9/ BMU- Abfallrichtlinie
BMU Guideline on Waste
Guideline on Control of Radioactive Wastes with Negligible Heat Production Not Delivered to a State Collecting Facility of January 16, 1989, Federal Bulletin No. 63 a of 16.01.1989, with Amendments of 26.06.1989 in Federal Bulletin No.124 of July 7, 1989, Last Amended by Amendment Federal Law Gazette No.19 of January 1, 1994
- /10/ BfS
Standortunabhängige Endlagerungsbedingungen, - Vorgehensweise und Inhalte – Entwurf
Site-independent Repository Conditions, Procedures and Contents – Draft
October 7, 2002
- /11/ Guideline Relating to Emission and Immission Monitoring of Nuclear Facilities
Circular of the BMU of June 30, 1993 – RS II 5 – 15603/5, incl. Amendment of March 20, 1996
- /12/ KTA 1404
Documentation during Construction and Operation of Nuclear Power Plants, (6/01)
- /13/ KTA 1201
Requirements for the Operating Manual, (6/98)
- /14/ KTA 1202
Requirements for the Testing Manual, (6/84)
- /15/ BLG
Technische Annahmebedingungen (TA) für das Abfalllager Gorleben
Technical Acceptance Criteria (TA) for the Interim Storage Facility Gorleben
-

Rev. 2.0, of 12/95

- /16/ RSK Guidelines for Pressurised Water Reactors, 3rd Edition of 14.10.1981 (Federal Bulletin 1982, No. 69a)
with amendments:
in 21.1 (Federal Bulletin 1984, No. 104)
in 21.2 (Federal Bulletin 1983, No. 106)
in 7 (Federal Bulletin 1996, No. 158a) with revision (Federal Bulletin 1996, No. 124) of 12/98

Appendix to Chapter 3:

Flow chart on product control of waste packages from nuclear installations (Example /8/)



Product control of waste packages from nuclear installations for their conditioning, interim storage or disposal

Flow chart legend

Waste producer/licensee:

Submits an application to the BfS and the supervisory authority on conditioning and inspection plans together with a plan of procedures. The state collecting facilities (*i. e. the collecting facilities of the Länder*) assume, among other things, the tasks of the waste producers within the frame of product control.

Application with flow chart:

An application may be submitted for the qualification of a procedure or a specific conditioning campaign (including sampling inspection) or a sampling inspection. The respective plan of procedures comprises all relevant work and inspection steps of the project with regard to the waste packages. The application with the part relevant to the verification that the final disposal requirements are met and the facility-specific and/or parts of the plan of procedures relevant to the interim storage facility is submitted to the BfS and the competent supervisory authorities by the waste producer/licensee.

Supervisory authority:

Competent for facilities and measures of the waste producer/licensee and for a potential interim storage facility. In accordance with Section 20 AtG, it commissions, if required, experts to review the documents submitted regarding compliance with the requirements of the respective nuclear facility or the interim storage facility in agreement with the experts consulted by the BfS. It grants the approval of performance of planned conditioning or interim storage. It informs the BfS of its decision.

Federal Office of Radiation Protection (BfS):

Commissions, if required, experts to review the documents submitted on the repository requirements in agreement with the experts consulted by the supervisory authorities. The BfS informs the competent supervisory authorities of the result of its review.

Pre-review:

Pre-review is the review of the plan of procedures submitted and, where required, further documents. It takes place campaign-dependent or campaign-independent on a conditioning procedure or a sampling inspection procedure. On the basis of the pre-view, the experts involved specify in the plan of procedures which inspections are regarded as necessary. Experts are commissioned in specific cases, as defined in the plan of procedures, in consultation with the BfS. The review results of the experts shall in each case be outlined in

one statement under consideration of the results of the consultation of the other experts involved, which forms the basis for the decision on the project applied for.

Approval of the joint plan of procedures:

It is given by the BfS regarding the verification that the requirements for final disposal have been fulfilled. The approval of implementation of the plan of procedures is granted by the competent supervisory authority.

Accompanying controls:

The inspections performed by the experts specified in the plan of procedures are performed and documented on behalf of the supervisory authority of the waste producer (also see pre-review). In case of external conditioning, the accompanying control is also performed on behalf of this authority with the possibility to consult local experts.

Experts:

The expert for accompanying controls summarises the results of the accompanying controls regarding the requirements of the interim storage facility and the repository in an inspection protocol for the supervisory authorities and the BfS. On the basis of this inspection protocol and review of the documentation, the BfS expert prepares an inspection report for the BfS.

Interim storage:

According to the requirements for the interim storage facility (interim storage as defined in Section 78 StrlSchV /2/ or in Section 6, para 1 AtG or as part of an activity subject to licensing pursuant to Section 7 or Section 9 AtG or other type of interim storage), the competent supervisory authority gives a permission on the emplacement. The BfS gives a statement on the compliance with the requirements for final disposal as far as it has the results of the examinations required from a repository point of view at that time.

Post conditioning:

In case of already pre-reviewed plans of procedures considering post-conditioning measures that might be required, still necessary post conditioning of waste packages requires accompanying controls. For waste packages to be subjected to post-conditioning without approved plan of procedures, the complete product control procedure shall be performed.

Repository:

The transport of the waste packages to the repository is subject to the permission of the BfS.
