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Bundesanstalt für Materialforschung und -prüfung

Remark

The german version is the only legally binding text.

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Ageing Management for Competent Authority Approved Package Designs for the Transport of Radioactive Material

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1 Scope

The guideline describes necessary measures concerning ageing management for competent authority approved package designs for the transport of radioactive material to ensure that the requirements according to the following regulations as well as the specifications according to the design approval certificate are met. Requirements of other legal provisions are not affected.

The guideline explains

- Ordinance on the Domestic and International Transport of Dangerous Goods by Road, Rail and Inland Waterways (Verordnung über die innerstaatliche und grenzüberschreitende Beförderung gefährlicher Güter auf der Straße, mit Eisenbahnen und auf Binnengewässern GGVSEB),
- Ordinance on the Transport of Dangerous Goods by Sea (Verordnung über die Beförderung gefährlicher Güter mit Seeschiffen GGVSee) und
- Luftverkehrs-Zulassungs-Ordnung (LuftVZO),

as far as on basis of the International Atomic Energy Agency (IAEA) recommendations for the safe transport of radioactive materials "Regulations for the Safe Transport of Radioactive Material – Specific Safety Requirements No. SSR-6" the package design has to be approved by the competent authority, for all designs of

- Type C, B(U) B(M) packages for radioactive materials,
- Packages for fissile material (CF, B(U)F, B(M)F, AF and IF),
- Packages for non-fissile or from the requirements on fissile materials excepted uranium hexafluoride (H(U) and H(M)).

Consideration of ageing mechanisms during design of packages according to para. 613A SSR-6 /1/ is the underlying basis for ageing management measures.

The ageing management shall be seen and organised as part of the management system according to para. 306 SSR-6 /1/.

The framework for quality assurance measures of packagings for competent authority approved package designs for the transport of radioactive material BAM-GGR 011 /2/ shall be respected.

2 Definitions for the purpose of this guideline

Deviation

Deviation is the non-conformance of a detected condition to a (specified) nominal condition.

Ageing

Ageing comprises the alteration of components or component groups of a package due to ageing mechanisms during package operation as well as the implications of amendment of the state of the art concerning a package design.

Ageing effects

Consequences of ageing mechanisms concerning a package design which lead to alteration of e.g. materials, components/component groups, coatings, conjunctions, inventories or operational

conditions taking into account the assessable/foreseeable operating time. This includes e.g. material removal due to corrosion, alteration of strength resulting from thermal loads, plastic deformation due to creep or hydrogen embrittlement of metals.

Ageing management

The ageing management comprises the entirety of organizational and technical measures that ensure the packaging/package conformity to the specification starting from commissioning until decommissioning of a package design.

Ageing management documentation (AMD)

AMD comprises the continuous documentation of conformity to the specification considering ageing aspects in the respective packaging and package specific documents.

Aging management plan (AMP)

Ageing induced alterations at packagings/packages of a package design shall be anticipated in the AMP during package operation. If applicable, measures for their control and monitoring shall be defined. The handling of the evolution of regulatory framework and safety case methods shall be stipulated.

Ageing mechanisms

Known physical, chemical or biological processes that may induce alterations in material and component structure and properties. This encompasses e.g. varied kinds of corrosion, radiolysis, creep, relaxation, wear and fatigue.

Ageing surveillance program (ASP)

The ASP[1] comprises all measures for monitoring and control of predicted alterations that may jeopardise the conformity to the specification of a package design.

Operation

Use, maintenance and periodic inspection of a packaging starting with inspection before commissioning.

Package/packaging operation time

Period of operation of a package/packaging starting with inspection before commissioning until decommissioning in the relevant field of law.

Operational experience

Findings that are detected or confirmed during package/packaging operation. This encompasses unexpected events and incidents.

Operational phases

For the ageing relevant application scenarios during package/packaging operation that may, from technical or organizational point of view, be separated, e.g. package loading.

[1] In the german version AÜP

Responsible person/entity for the operation

For the operational phase of a packaging/package responsible person/entity according to the relevant legal provision

State in accordance with the specification

The detected condition of a packaging/package is conform to the legal provisions and the in the package approval specified nominal condition for a package design.

Transportability

State of a package in accordance with the specification that allows transportation in the public domain.

3 Package classification by means of use

The type of use for a packaging is decisive for the determination of measures concerning ageing management. Subsequently, a classification resulting from package operation into three different groups is done.

Packages intended for single use

Measures for ageing management may be omitted for packages that are foreseen for one-time use only without prior storage. Ageing mechanisms and their consequences are to be assessed during design.

Packages intended for repeated use

Ageing mechanisms and their consequences during package operation time shall be assessed for packages intended for repeated use. Corresponding measures shall be implemented. Range and scale of proofs as well as the manner of measures for ageing management are to be gathered from sections 4 and 6 of this guideline.

Packages intended for transport after storage

Packages intended for transport after storage are subject to special constraints. The state of all package components and the radioactive inventory in accordance with the specification according to the legal provisions is to be ensured prior transportation.

The impact of the radioactive inventory onto the package components shall be incorporated. Alterations of the radioactive contents itself may impact the safety objectives and is to be assessed. Inspections and maintenance may only be performed on loaded packages. Range and scale of proofs as well as the manner of measures for ageing management are to be gathered from sections 4 and 6 of this guideline.

4 Consideration of ageing mechanisms during design phase

4.1 General aspects

The safety-related proofs for a package design shall be documented under consideration of ageing mechanisms in appropriate manner e.g. by technical reports in package design safety report (see /4/). An essential part is the identification of relevant ageing mechanisms, their transfer to components/component groups and the analysis and assessment of resulting ageing effects under consideration of the conditions during the expected operational phases. The following items shall be considered.

- Determination of parameters resulting from operation of a package design e.g. from surroundings (e.g. humidity, thermal loads), handling (e.g. static and dynamic loads), construction (e.g. pressurisation, compression, contact of different materials), inventory (e.g. radiation, fissile products, thermal loads) or chemical reactions (e.g. radiolysis)
- Description of parameters, which have to be considered as ageing mechanisms and which influence in a relevant manner the ageing of the package design.
- Analysis and assessment of relevant safety-related ageing mechanisms regarding their impact on materials, components, component groups, coatings, conjunctions, inventories or operational conditions of a package design (section 4.3). Possible combined impact of different ageing mechanisms, e.g. time, temperature and radiation, shall be considered.
- Prediction and description of ageing effects on materials, components, coatings, conjunctions, inventories or operational conditions and assessment compared to the defined specification of package design.
- Compilation of a monitoring and control program for ageing effects with the aim to maintain the state of package design in accordance with the specification (section 6.2).

4.2 Assessment basis

Reference data for design determined characteristic values and stated design values of package design generate the basis for the assessment of ageing effects on components or component groups of packaging or on the inventory. Possible is also an assessment of ageing effects based on real existing loadings and capacities with respect to the defined design values.

Reference data for characteristic values relevant for the design like e.g. tightening torques of screws, strength, fracture toughness, microstructures, absorber concentrations, moderator densities are to be taken from the package design safety report. Additional information may be extracted from documentation of experimental examinations and materials and components qualifications. For separate packagings manufacturing documentation, documentation of inspections before commissioning and periodic inspections may also be used.

Design values should be derived from the characteristic data report according to /4/ and from specific proofs in the package design safety report, e.g. for the cask body, the attachment points or the basket. Typical parameters relevant for design values are e.g. permissible strength, permissible strains, permissible toughness, maximum temperatures, maximum pressures and a permissible number of cyclic loadings.

4.3 Requirements for the range and scale of proofs

The assessment of ageing effects may be divided into separate components/component groups and inventories for a packaging design.

For components/component groups the requirements for the range and scale of proofs are dependent on

- the classification defined in terms of dangerous goods regulation for components/component groups according to BAM-GGR 011 /2/ and
- the practicable and organizational realistic accessibility and replaceability of components/component groups during operation, which is to a large degree determined by the package classification by means of use (section 3).

The requirements are contained in table 1. The proofs are to be made according to the state of the art.

A component/component group is accessible if non-destructive testing like visual testing, penetrant testing, magnetic particle testing and ultrasonic testing is possible without obstruction. A component/component group is replaceable if it is possible to substitute the suitable whole component itself.

component/ component group	Requirements for the range and scale of proofs
not accessible	The ageing of materials, components, layers, connections and operation conditions to be considered has to be analyzed and assessed. Therefore, detailed demonstrations for identical materials and structures should be performed. For components/component groups classified as grade 1 according to BAM-GGR 011 theoretical demonstrations may have to be substantiated by experimental investigations.
accessible / not replaceable	The ageing of materials, components, layers, connections and operation conditions to be considered has to be analyzed and assessed. The proof may include measures of continuous monitoring, periodic testing, maintenance or repair as part of the ASP according to section 6.2.
replaceable	The ageing of materials, components, layers, connections and operation conditions to be considered has to be analyzed and assessed. The proof may include measures of continuous monitoring, periodic testing, maintenance or repair as part of the ASP according to section 6.2.

Table 1: Requirements for the range and scale of proofs for the ageing of components/component groups

Ageing of the inventory is of relevance, if applicable, in terms of dangerous goods regulation for the proofs of dose rate threshold limits, criticality safety, leak tightness respectively activity release of the package design. Radiation and development of heat favour ageing mechanisms such as corrosion, gas formation or embrittlement for the inventory. The safety case for a transport after storage shall consider all relevant changes of the inventory. Requirements regarding the range and scale of proofs according to Table 1 “not accessible” apply, except when otherwise stated.

5 Ageing management organization

5.1 General

Ageing management comprises the entirety of organizational measures for the developmental adaptation of documents and records and the technical measures which ensure the condition of packagings/packages in accordance with the specification from commissioning to decommissioning.

The measures for ageing management shall be suitably presented and integrated, e.g. into the general management system according to § 306 SSR-6 /1/. Compliance with the requirements of this guideline on ageing management shall be ensured. Competences and responsibilities for ageing management including the definition of measures shall be defined within the organization of the applicant or approval holder.

Changes in the underlying regulations and standards shall be regularly reviewed by the applicant or approval holder with regard to their relevance for ageing management. Relevant changes are to be evaluated. The constant development and change of the state of the art shall be taken into account for ageing management. It shall be ensured that new recognised approaches and findings on proof, testing and monitoring methods and on ageing mechanisms and their resulting ageing effects are taken into account.

The availability and manufacturability of components and the assurance of the applicability of procedures in accordance with the specification shall be taken into account in the evaluation of the current state of the art. Archiving of relevant documents and records shall be ensured over the whole package operation time for the documentation of ageing management.

5.2 Responsibilities

The applicant or approval holder is responsible for ensuring preparation of ageing management documents.

The approval holder is responsible for ensuring the submittance of the ageing management measures required for operation, in particular the ageing surveillance program (ASP), to the person or entity responsible for operation of the packaging.

The applicant or approval holder shall take into account the provision of spare parts and the feasibility of repair measures in accordance with the specification.

The approval holder shall ensure experience feedback from operation.

5.3 Structure of measures

Ageing management comprises systemic and design-related measures.

The specific design and all possible operating conditions from commissioning to decommissioning shall be taken into account in the design-related measures. These measures are aimed at capturing the ageing effects from the proofs for the foreseeable ageing of a design in accordance with section 4 regarding compliance with the specification. The monitoring and control of ageing effects shall be identified in an ageing surveillance program (ASP) and the procedure for changes in technical regulations and safety methods shall be described accordingly. The design-related measures for ageing management are specified in the AMP (section 6).

The continuous documentation for compliance with the specification for a packaging/package of a design type is to be carried out in the AMD (Section 7).

5.4 Testing of the measures

The verification of ageing management measures shall be performed depending on the type and use of the package.

The ageing management is assessed by BAM in the course of the package design approval procedure when the package design approval is applied for the first time and then regularly within the scope of the conditions defined in the approval, at the latest, however, when the approval validation is extended, or if there is a justified reason.

As a rule, competent authority approval is limited to 3 years in accordance with guideline R 003 /3/. Differing periods of validity are possible if they are applied for and justified by the applicant. The requirements and conditions for longer validity periods are described in /5/. The requirements for ageing management may be divided into approval validity periods of a maximum of 5 years and longer than 5 years.

An evaluation period starting from the time of commissioning of the packaging to at least the end of the requested validity period of the approval is to be assumed for the extension of an approval.

Validity period of the approval of maximum 5 years

For package design types with a maximum approval validity of 5 years, the ageing management of the applicant/approval holder is evaluated by BAM in the course of the design approval when the package design approval is applied for the first time. Otherwise, the review of the ageing management is carried out regularly as part of the extension/revision of the package design approval or when there is a justified reason.

The documents for ageing management shall be submitted by the approval holder when applying for the extension/revision of the package approval for already approved package designs with a maximum validity of 5 years. The ageing management documents will be assessed by BAM.

For the extension of the approval, the requirements according to guideline R 003 /3/ shall generally also be fulfilled with regard to the documents concerning ageing management. Supplementary information is given in sections 6 and 7.2.

Validity period of the approval of more than 5 years

Package designs of packagings for transport after storage which meet certain boundary conditions with regard to storage, manufacturing and loading may be granted approval with a period of validity of more than 5 years. At the time of application and then every 5 years, the applicant shall submit an assessment report on ageing management to the Federal Office for the Safety of Nuclear Waste Management (BASE) and to BAM. Details on the conditions, procedure and required proofs may be found in /5/.

The experience feedback for the evaluation period from the storage of the package design, especially with regard to AMP and AMD, is of great importance.

6 Ageing management plan (AMP)

6.1 Preface

The specification of measures for the ageing management of a package design is carried out by the applicant resp. the approval holder in the AMP. The measures related to the package design shall capture both the ageing mechanisms and the ageing effects according to section 4. This includes the measures of the ageing monitoring program for monitoring and control as well as changes due to developments in technical basis (changes of requirements, standards, proof concepts etc.).

For package designs kept in interim storage additionally a gap analysis program shall be provided. It shall contain an evaluation of changes in the requirements, in the state of the art und in the state of the package design during storage.

The requirements for the AMP of a package design are defined mainly by the type of use of the packaging/package according to section 3 and by the accessibility as well as the replaceability of the components or component groups according to section 4.

The approval holder shall specify procedures, which provide an experience feedback about noticeable problems during operation of packagings/packages (section 7.2). It shall be ensured that this information taken into account for the verification of the compliance with the specification according to section 4.

6.2 Ageing surveillance program (ASP)

Changes of the package design, which are already predicted and evaluated during the package design as part of the ageing assessment and which may influence the state in accordance with the specification during package operation time shall be recorded and managed by suitable specifications and measures. The measures for the ageing monitoring shall be integrated in a suitable form, e.g. by test plans or test- and maintenance instructions, into the operational documents of the package design.

A corresponding program for monitoring the changes shall be developed for the measures. The program may provide measures for the affected components or component groups as well as for specific ageing mechanisms. The ASP shall be integrated in the package design safety report.

The measures shall serve to detect, monitor, prevent, reduce and evaluate ageing effects. This may be e.g. measures of continuous monitoring of the packaging/package, monitoring or testing of external samples or components under corresponding conditions, periodic testing, maintenance, repair or replacement of components or component groups. Range and scale of measures are influenced by the type of use for a packaging/package and by the accessibility resp. replaceability of the components or component groups. For example, for packagings/packages intended for repeated use accessibility may be assumed. Therefore periodic inspection, regular maintenance, repair or the defined replacement of components or component groups may be applied here (section 4.3) and form the essential part of the ASP.

The methods of monitoring shall meet the state of the art. This may be e.g. visual testing, material analysis, loading tests, leak testing, non-destructive testing and activity measurements.

The continuous and systematic transfer of results of ageing monitoring to the AMD shall be ensured. In order to illustrate the consequences of ageing effects on components/component groups the inventory or the operating condition, suitable representations over the operation time shall be provided.

6.3 Gap analysis program

A systematic procedure (gap analysis program) for a periodic evaluation of the changes in the regulations, the state of the art and the condition of the package design shall be provided during storage for packages intended for transport after storage according to SSR-6 /1/.

Changes in the regulations, rules and standards included in the design documents shall be checked and evaluated regarding their relevance to the ageing management for a package design. If relevant changes are incorporated into documents, care should be taken to ensure transparent and comprehensible updates. Revised documents are to be submitted to BAM and BASE for assessment.

Changes in characteristic values compared to the limit values as package design safety report basis are to be evaluated taking into account further development of regulations and standards.

7 Ageing Management Documentation (AMD)

7.1 General aspects

The aim of AMD is to ensure the ongoing documentation of compliance with the package specification in the packaging and package-specific documents during the entire package operation time. The AMD includes e.g. relevant protocols that have to be filled out for each package/packaging according to the operating instructions of the package design, e.g. during loading and unloading. This may also include the package design specific ASP, which contains the measures regarding monitoring and the resulting protocols, documentations and measurement data.

The documentation shall be transparent and comprehensible ensuring understanding of decisions and actions.

In general, the documentation should be archived in the logbook for each packaging/package. The results of the ageing monitoring, their evaluation and the derived measures shall be presented clearly and recognizably. Deviations from manufacturing or operation having significant impact on ageing management shall also be included here.

7.2 Operational experience

It shall be ensured that the person/company responsible for operation forwards experience feedback about the operation of the packaging/packages of a package design to the approval holder for the different operational phases at regular intervals, at the latest every 5 years. Previous experiences, e.g. in handling, loading and unloading, transport or storage, that have since commissioning been made with the packagings/packages, shall be presented. Unexpected events and occurrences including associated measures shall be described. Known experience from the operation of similar packagings or packages shall be included. The operational experiences shall be compared with the measures and results of the ASP and shall be subjected to an assessment by the approval holder with regard to the effects on ageing and ageing monitoring.

7.3 Deviations

Deviations from manufacturing or packaging operation that may have significant impact on ageing management shall be documented and assessed in deviation reports /2/. The deviations, including the corrective actions shall be taken into account in the AMP.

8 Transportability of packages

The ageing management measures defined in this guideline are intended to ensure that the packaging/package is in a state in accordance with the specification for the transport. The structure of the ageing management is an essential component, which ensures the identification and monitoring of ageing both organizationally and technically and ensures the application of the current standards and the current state of the art.

9 References

/1/ International Atomic Energy Agency (IAEA).
Regulations for the Safe Transport of Radioactive Material, 2018 Edition. Specific Safety Requirements No. SSR-6 (Rev. 1), Vienna, 2018

/2/ BAM-GGR 011:
Quality Assurance Measures of Packagings for Competent Authority Approved Package Designs for the Transport of Radioactive Material (BAM-GGR 011) Rev. 1, October 1st, 2018, Amts- und Mitteilungsblatt der BAM Volume 48, 3/2018, S. 109-121.

/3/ Bundesministerium für Verkehr und digitale Infrastruktur.
Guideline for the design approval procedure of packages for the transport of radioactive material, of special form radioactive material, low dispersible radioactive material and excepted fissile material – R 003 – September 17th, 2019 (VkBl. 2019, p. 618).

/4/ European PDSR-Guide ISSUE 3 (December 2014), Technical Guide, Package Design Safety Reports for the Transport of Radioactive Material

/5/ Bundesamt für die kerntechnische Entsorgungssicherheit
Bauart-Zulassungen von Versandstücken zur Beförderung radioaktiver Stoffe: Gültigkeitsdauern, Voraussetzungen und Bedingungen, Bundesamt für kerntechnische Entsorgungssicherheit (BfE), Salzgitter, August 2018.