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FORMAT AND CONTENT OF THE
PACKAGE DESIGN SAFETY REPORT
FOR THE TRANSPORT OF
RADIOACTIVE MATERIAL

[[MEMBER STATES LIST]]

STEP 12

IAEA SAFETY STANDARDS SERIES No. SSG-66

FORMAT AND CONTENT OF THE
PACKAGE DESIGN SAFETY REPORT
FOR THE TRANSPORT OF
RADIOACTIVE MATERIAL

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, ~~20xx~~2022

STEP 12

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FOREWORD

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STEP 12

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1. INTRODUCTION

BACKGROUND

- 1.1. Requirements for the safe transport of radioactive material are established in IAEA Safety Standards Series No. SSR-6 (Rev. 1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition [1] (hereinafter referred to as ‘the ‘Transport Regulations’).
- 1.2. Packages intended for the transport of radioactive material are required to be designed to meet the applicable national and international regulations, and, as such, documentary evidence of compliance of a package design with the applicable regulations ~~will be~~ required.
- 1.3. For package designs that require approval by a competent authority, the package design safety report (PDSR) is the basis for the application to the competent authority for approval of the design.
- 1.4. For package designs where competent authority approval is not required, documentary evidence of compliance of the package design with all applicable requirements is required ~~in order~~ to meet para. 801 of the Transport Regulations. In addition, for packages that do not require competent authority approval, some form of ‘certificate of compliance’ ~~could~~ with all the applicable requirements of the Transport Regulations might need to be applied (see para. 801.3 of IAEA Safety Standards Series No. SSG-26 (Rev. 1), Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2018 Edition) [2]), and ~~the~~ PDSR would be an appropriate form of documentary evidence of compliance with the Transport Regulations.
- 1.5. In this Safety Guide, all documentary evidence of compliance of a package design with the Transport Regulations will be called a PDSR, irrespective of whether ~~or not~~ the package design requires competent authority approval.
- 1.6. This Safety Guide is based on the Transport Regulations. The Transport Regulations also constitute the basis of the United Nations Recommendations on the Transport of Dangerous Goods [3] and of other relevant international, regional and national regulations, for all modes of transport.
- 1.7. The format of this Safety Guide is based on the European Technical Guide on Package Design Safety Reports for the Transport of Radioactive Material [4].
- 1.8. The definitions stated in the Transport Regulations and the terms defined and explained in the IAEA Safety Glossary [5] apply ~~for~~ to this Safety Guide.

OBJECTIVE

- 1.9. The objective of this Safety Guide is to provide recommendations on the preparation of a PDSR to demonstrate compliance of a package design for the transport of radioactive material with the Transport Regulations.
- 1.10. This Safety Guide is intended for use by applicants for approval of package designs, ~~in case of (when~~ package designs are subject to competent authority approval, ~~and for)~~ as well as by package designers and/or consignors, ~~in case of (when~~ package designs do not ~~requiring~~ require competent authority approval,) to demonstrate compliance with the requirements of the Transport Regulations applicable to the respective package type.
- 1.11. This Safety Guide could be also used to demonstrate compliance with any national or international regulations relating to package design, if the national or international regulations are based on the Transport Regulations. This Safety Guide does not replace the Transport Regulations or limit

their application. Moreover, following the recommendations of this Safety Guide does not relieve the package designer ~~from~~of the need for any additional analysis associated with a specific package design as required by the ~~CA~~competent authority.

1.12. This Safety Guide provides an example of the structure and format for a PDSR but does not intend to replace any existing format for a PDSR that might be determined by national regulations or standards for packages intended for domestic use only.

1.13. In the event of a conflict or anomaly between the provisions of the Transport Regulations and this Safety Guide, the requirements in the Transport Regulations apply. For regulatory purposes, reference should be made to the detailed provisions of the Transport Regulations.

SCOPE

1.14. This Safety Guide covers package designs requiring competent authority approval in accordance with para. 802 of the Transport Regulations for the following types of package:

- Type B(U) packages;
- Type B(M) packages;
- Type C packages;
- Packages containing fissile material not excepted by paras 417, 674 or 675 of the Transport Regulations;
- Packages designed to contain 0.1 kg or more of uranium hexafluoride.

1.15. This Safety Guide also covers package designs not requiring competent authority approval for the following types of package:

- Excepted packages;
- Industrial packages Type 1 (Type IP-1);
- Industrial packages Type 2 (Type IP-2);
- Industrial packages Type 3 (Type IP-3);
- Type A packages.

1.16. Designs ~~off~~or special form radioactive material, designs ~~off~~or low dispersible radioactive material, unpackaged low specific activity material (LSA-I material) and unpackaged surface contaminated objects (SCO-I and SCO-III) are outside the scope of this Safety Guide.

STRUCTURE

1.17. Section 2 of this Safety Guide provides general recommendations on the PDSR. Appendices I ~~to~~ ~~IV~~ describe the information that should be provided in the PDSR for, respectively, excepted packages; industrial packages; Type A packages; and Type B(U), Type B(M) and Type C packages, ~~respectively~~. Appendix V describes the additional information that should be provided in the PDSR for packages containing fissile material. Appendix VI describes the additional information that should be provided for packages containing 0.1 kg or more of uranium hexafluoride. Annex I provides a matrix of the applicable paragraphs of the Transport Regulations to be included in the demonstration ~~for~~of compliance for each package type and additional provisions for packages containing fissile nuclides and packages containing 0.1 kg or more of uranium hexafluoride. Annex II provides a list of reference

publications used by different competent authorities for the technical assessment of ~~the~~ package design. Annex III provides information on the structure of the PDSR for the packages addressed in Appendices I-IV.

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2. GENERAL RECOMMENDATIONS FOR THE PACKAGE DESIGN SAFETY REPORT

2.1. The package designer is the person or organization that takes ~~the~~ responsibility for the complete package design. For each package design there should be only one package designer, who should also issue the PDSR.

2.2. In accordance with para. 306 of the Transport Regulations, a management system is required for package design. The PDSR should be a controlled document¹, approved for issue in accordance with the package designer's management system. It should be signed and dated and should indicate its revision number or issue status. The PDSR should include a contents list, and the total number of pages and annexes of the PDSR should be indicated. Any changes between revisions of the PDSR should be clearly documented. The PDSR should include a record of its production, review and approval by the package designer. ~~More~~Further recommendations on the management system for transport are provided in IAEA Safety Standards Series No. TS-G-1.4, The Management System for the Safe Transport of Radioactive Material [6]. A PDSR is typically divided into two parts. Part 1 of the PDSR should contain the information that supports the demonstration of compliance with the Transport Regulations. Part 2 of the PDSR should contain detailed technical analyses supporting this information. Figure 1 shows a generic structure and the recommended contents of a PDSR that apply to all package types.

2.3. The structure of the PDSR should be the following, as shown in ~~Figure~~Fig. 1:

- Table of contents of the PDSR.
- Part 1: Information supporting the demonstration of compliance with the Transport Regulations:
 - Administrative information;
 - Specification of the contents;
 - Specification of the packaging;
 - Ageing considerations;
 - Conditions for technical analyses;
 - Compliance with regulatory requirements;
 - Package operations;
 - Maintenance;
 - Gap analysis programme;
 - Management system;
 - Package illustration.
- Part 2: Technical analyses:
 - Structural analysis;
 - Thermal analysis;
 - Containment design analysis;
 - Dose rate analysis;
 - Criticality safety analysis;
 - Other analyses.

2.4. A table showing the structure of the PDSR for Appendices I ~~to~~ VI is provided in Annex III.

¹ A 'controlled document' is a document that is approved and maintained within a management system.

2.5. The following general considerations should be taken into account for all technical analyses in Part 2 of the PDSR:

- (a) Indication of the package design;
- (b) Package design acceptance criteria² and design assumptions;
- (c) Description and explanation of the choice of ~~the~~ analysis methods;
- (d) Analysis of the package design;
- (e) Comparison between the acceptance criteria and the results of the analyses.

2.6. The PDSR may be compiled as a single document or as an integrated set of individual documents. Each individual document in Part 1 and ~~in~~ Part 2 of the PDSR should also be a controlled document. Each individual document in Part 2 of the PDSR should be produced and verified by specialists in the technical area being assessed.

2.7. The scope and technical content of the PDSR should be set at the appropriate level for each type of package, by adopting a graded approach consistent with para. 104 of the Transport Regulations. Depending on the package type, some of the items included in the contents of the PDSR in para. 2.43 are not needed. More detailed information on the content of the PDSR for each package type is provided in Appendices I ~~to~~ VI.

2.8. A PDSR should contain controlled engineering drawings that show the details used in the demonstration of compliance with the regulations. For complex packages, this may involve several large drawings, necessary for modelling and assessing the package for calculations relating to mechanical strength, heat transfer, dose rates and criticality, ~~and; these~~ are often called "design drawings". ~~drawings~~. For simple packages, such as excepted packages, that do not need the same level of detail as complex packages for the demonstration of compliance, these drawings may be simple and are ~~named~~ "often called 'schematic drawings'". ~~drawings~~.

2.9. A reproducible illustration of the package should be included at the end of Part ~~I~~ of the PDSR. In accordance with para. 809 ~~and 812(i)~~ of the Transport Regulations, a reproducible illustration, not larger than 21 cm × 30 cm, showing the make-up of the package is requested to be part of the application for approval. This illustration does not need to be very detailed, ~~but~~ should present an overview of the package and should fit ~~in~~ on one page.

2.10. The ~~international system~~ International System of ~~units~~ Units (SI) should be used throughout the PDSR.

² In the context of this Safety Guide, -'acceptance criteria' are the limits on the value of an indicator (i.e.: loss of radioactive content, dose rate, temperature, subcriticality), specified by the regulatory body and used to assess the ability of a package to perform its function according to the design.

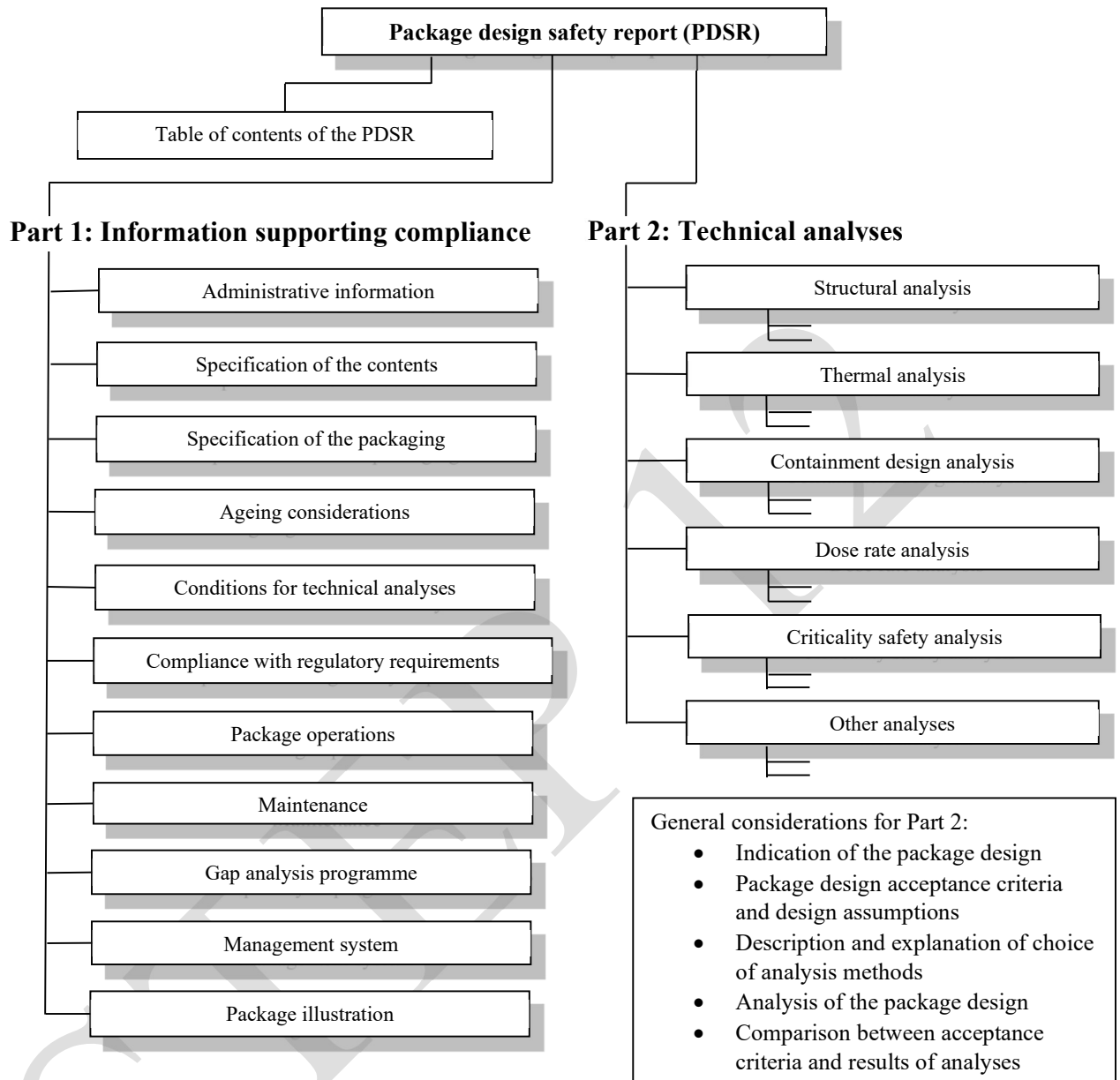


FIG. 1. Structure and contents of a package design safety report.

APPENDIX I. EXCEPTED PACKAGES

I.1. This appendix provides specific recommendations on the information that should be included in Parts 1 and 2 of the PDSR for excepted packages. Table 1 lists each item of the PDSR with applicable information and guidance. Further recommendations on excepted packages are provided in SSG-26 (Rev. 1) [2].

I.2. In accordance with para. 801 of the Transport Regulations, excepted packages require a PDSR. In accordance with the graded approach and taking into consideration the lower risks presented by excepted packages, ~~the PDSR~~ their PDSRs may be less extensive than those for other types of package.

I.3. For packages containing fissile materials to be transported as excepted packages, one of the provisions of para. 417 of the Transport Regulations is required to apply.

I.4. Packages containing less than 0.1 kg of uranium hexafluoride may be classified as UN 3507 and transported as excepted packages under the provisions of para. 425 of the Transport Regulations. More information on the applicable regulations for the carriage of UN 3507 is available in ~~Chapter~~ chapter 3.2 of Ref. [3].

I.5. For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.4. of the PDSR or, if necessary, in Part 2 of the PDSR.

I.6. For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely identified by precisely indicating a schematic drawing of the packaging (see item 1.3. of the PDSR), including its revision number, and the specification of the contents (see item 1.2. of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry and performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design specifications provided in items 1.2. and 1.3. of the PDSR or to other assumptions derived from the design specifications and used in the technical analyses.
- (c) The results of the technical analyses should be compared with the acceptance criteria and package design assumptions, and regulatory compliance should be justified accordingly.

I.7. The following items listed in ~~Figure~~ Fig. 1 and para. 2.3 of this Safety Guide are not relevant to and not needed for excepted packages; and, therefore, are not included in Table 1:

— Part 1:

- Ageing considerations;
- Conditions for technical analyses;
- Gap analysis programme;
- Package illustration.

— Part 2:

- Thermal analysis;
- Containment design analysis;
- Criticality safety analysis;
- Other analyses.

APPENDIX I – EXCEPTED PACKAGES

TABLE 1. PDSR PACKAGE DESIGN SAFETY REPORT FOR EXCEPTED PACKAGES

TABLE OF CONTENTS OF THE <u>PACKAGE DESIGN SAFETY REPORT (PDSR)</u>
The contents of the PDSR, Part 1 and Part 2, should be listed here, including the revision number of each individual document included in the PDSR.
Part 1
1.1. ADMINISTRATIVE INFORMATION
The following administrative information should be provided: <ul style="list-style-type: none">(a) Identification of the package designer (<u>i.e.</u> name, address, contact details);(b) UN number of the package, as applicable;(c) Modes of transport for which the package is designed, and any operational restrictions associated with the<u>any</u> mode of transport;(d) Reference to the applicable regulations for the specific package design, including the edition of the Transport Regulations to which the package design is referring.
1.2. SPECIFICATION OF THE CONTENTS
A detailed description of the permitted contents of the package design should be provided by , stating — at a minimum, — the following information, as applicable: <ul style="list-style-type: none">(a) The general nature of contents (e.g. articles, instruments, metallurgical specimens, internal contamination of the package);).(b) The nuclides and/or nuclide composition, including progeny radionuclides ;.(c) The A_1 and/or A_2 values of the radionuclide <u>radionuclides</u> to be carried in the package. The A_1 and/or A_2 values for radionuclides that are not listed in <u>Table table 2</u> of the Transport Regulations are required to be determined in accordance with paras 403 — 407 of the Transport Regulations and may be subject to multilateral approval in accordance with para. 403 of the Transport Regulations.(d) The physical and chemical state of the contents ;.(e) The type and characteristics of the radiation emitted by the contents of the package ;.(f) Limitations on activity, mass and activity concentrations, and heterogeneities in the distribution of the nuclides. Compliance with the activity limits for excepted packages in accordance with <u>Table table 4</u>, paras 423 (e) and 424 (c) (for transport by post), para. 425 (for uranium hexafluoride) and para. 427 (for empty packagings) of the Transport Regulations, as applicable, is required ;.(g) A valid certificate for special form radioactive material or low dispersible radioactive material, when such material is included in the package ;.(h) The mass of fissile material, the nuclides and the enrichment of the contents, when fissile material excepted under para. 417 of the Transport Regulations is included in the package ;.(i) Other dangerous properties of the contents. In accordance with para. 618 of the Transport Regulations, any other dangerous properties (subsidiary hazards) of the contents of the package are required to be taken into account in the package design to be in compliance with the relevant transport regulations for dangerous goods. Additional information on the classification and design requirements for dangerous goods in accordance with the predominant subsidiary hazard can be found in <u>Ref. [chapter 3], Chapter 3.3</u>, Special Provision 290 , of <u>Ref. [3]</u>. Regarding packages containing

APPENDIX I – EXCEPTED PACKAGES

TABLE 1. PDSR PACKAGE DESIGN SAFETY REPORT FOR EXCEPTED PACKAGES

<p>less than 0.1 kg of uranium hexafluoride, that are excepted in accordance with para. 425 of the Transport Regulations and that are classified as UN 3507, additional information can be found in <u>Chapterchapter</u> 3.2 of Ref. [3] (or of<u>in</u> the applicable regulations for the carriage of dangerous goods);).</p> <p>(j) Other limitations to<u>on</u> the contents.</p>
<h3>1.3. SPECIFICATION OF THE PACKAGING</h3>
<p>The packaging design should be defined to the extent necessary to demonstrate compliance with the Transport Regulations, including; the following information <u>should be included</u>, as applicable:</p> <ul style="list-style-type: none">(a) Schematic drawings;(b) The overall dimensions and the maximum mass of the package when fully loaded;(c) A list of all packaging components important to safety and their materials;(d) The maximum normal operating pressure (in <u>the</u> case of air transport). <p><u>Note</u>: For radioactive material having<u>that has</u> other dangerous properties, the packing instructions appropriate to the other dangerous properties of the radioactive material are specified in <u>Ref. [3], see paragraphpara.</u> 4.1.9.1.5 <u>of Ref. [3]</u> (or in the applicable regulations for the carriage of dangerous goods). For packages containing less than 0.1 kg of uranium hexafluoride, the packing instruction P603 in <u>Chapterchapter</u> 4.1 of Ref. [3] is applicable.</p>
<h3>1.4. COMPLIANCE WITH REGULATORY REQUIREMENTS</h3>
<p>The PDSR should include a complete list of all paragraphs of the international regulations [1, 3]<u>Transport Regulations</u> and other international or national regulations applicable to the respective package design.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be done<u>demonstrated</u> using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for excepted packages are provided in a matrix in Annex I.</p>
<h3>1.5. PACKAGE OPERATIONS</h3>
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p> <ul style="list-style-type: none">(a) Assembling<u>Assembly</u> of the packaging components;(b) Loading and unloading of the package contents;(c) Controls before each shipment;(d) Handling and tie-<u>down</u>. <p>If written procedures with a detailed description of these activities are available, then reference should be made to these procedures.</p>
<h3>1.6. MAINTENANCE</h3>
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p>

APPENDIX I – EXCEPTED PACKAGES

TABLE 1. PDSR PACKAGE DESIGN SAFETY REPORT FOR EXCEPTED PACKAGES

<p>(a) Maintenance and inspection before each shipment;</p> <p>(b) Maintenance and inspection at periodic intervals throughout the lifetime use of the packaging and/or package.</p> <p>When developing the <u>maintenance</u> specifications for maintenance to be included in this <u>section item</u> of the PDSR, the following points should be taken into account:</p> <p>(1) Inspection of the package before shipment might be sufficient for excepted packages.</p> <p>(2) For single use packages, periodic maintenance does not need to be considered.</p> <p>(3) If written procedures with details of the package maintenance activities are available, then reference should be made to these procedures.</p>
<h3>1.7. MANAGEMENT SYSTEM</h3>
<p>The PDSR should include the specification of <u>specify</u> the management system that is established and implemented by the package designer, as required in accordance with para. 306 of the Transport Regulations, to demonstrate compliance with the relevant provisions of the Transport Regulations.</p> <p>The management system should be commensurate with the complexity of the package design and should include a reliable document control system.</p> <p>More <u>Further</u> recommendations on the management system for transport are provided in TS-G-1.4 [6].</p>
<h2>Part 2</h2>
<h3>2.1. STRUCTURAL ANALYSIS</h3>
<p>The results of the assessment of the mechanical behaviour (including, as applicable, analysis of fatigue, brittle fracture and creep) for routine conditions of transport should be included in this <u>section item</u> of the PDSR.</p> <p>The assessment of the mechanical behaviour should demonstrate compliance with the following requirements:</p> <p>(a) The requirements for the lifting attachments established in paras 608- and 609 of the Transport Regulations;</p> <p>(b) The requirements for the packaging attachments used for restraining to <u>restrain</u> the package to <u>within</u> its conveyance during transport;</p> <p>(c) For packages to be transported by air, the additional requirements for the package components of the containment system established in paras 619- 621 of the Transport Regulations.</p> <p>If the package is to be transported by air, the structural analysis of the containment system should take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport, as well as the specific temperature and pressure requirements for air transport.</p> <p>Attention should be paid to ensure <u>ensuring</u> that any nuts, bolts and other retention devices maintain their safety functions during routine conditions of transport, even after repeated use.</p> <p>Further recommendations are provided in paras 607.1- 621.3 of SSG-26 (Rev. 1) [2].</p>
<h3>2.2. DOSE RATE ANALYSIS</h3>

APPENDIX I—EXCEPTED PACKAGES

TABLE 1. PDSR PACKAGE DESIGN SAFETY REPORT FOR EXCEPTED PACKAGES

The dose rates at the external surface of the package for routine conditions of transport should be assessed to demonstrate compliance with the requirements for excepted packages established in paras 516 and 423(a), as applicable, of the Transport Regulations.

The dose rate analysis should be based on assuming the maximum radioactive content of the package or such ~~a~~ content for an excepted package ~~that~~as would create the maximum dose rate at the surface of the package.

The dose rate analysis should take into account the most recent ~~ICRP~~International Commission on Radiological Protection recommendations on nuclear decay data for dosimetric calculations (e.g., see Ref. [97]).

In accordance with para. 516.5 of SSG-26 (Rev. 1) [2], the maximum dose rate should be determined taking into account potential amplifying phenomena, such as internal movement of the contents; or, in the case of packages containing liquids, change in the state of the contents, including segregation and precipitation of the radionuclides.

If dose rate measurements are used in the analysis, the source used for the measurements should be representative of the radioactive contents specified in the package design.

DRAFT

APPENDIX II. INDUSTRIAL PACKAGES

II.1. This appendix provides specific recommendations on the information that should be included in Parts 1 and 2 of the PDSR for industrial packages. Table 2 lists each item of the PDSR, with applicable information and guidance. Further recommendations on industrial packages are provided in SSG-26 (Rev. 1) [2].

II.2. In accordance with para. 801 of the Transport Regulations, Type IP-1, Type IP-2 and Type IP-3 packages require a PDSR. In accordance with the graded approach, and taking into consideration the lower risks presented by Type IP-1 packages, the PDSR for Type IP-1 packages may be less developed than those for other types of package.

II.3. For industrial packages containing fissile nuclides, in addition to the recommendations ~~of~~ in this appendix, see also Appendix V.

II.4. For packages containing 0.1 kg or more of uranium hexafluoride, in addition to the recommendations ~~of~~ in this appendix, see also Appendix VI.

II.5. For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.5. of the PDSR or, if necessary, in Part 2 of the PDSR.

II.6. For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely identified by precisely indicating a drawing of the packaging (see item 1.3. of the PDSR), including its revision number, and the specification of the contents (see item 1.2. of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry or performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design ~~specifications~~ specifications provided in items 1.2. and 1.3. of the PDSR or to other assumptions derived from the design specifications and used in the technical analyses. All mechanical, thermal and shielding characteristics of each component of the package and the acceptance criteria used in technical analyses should be defined.
- (c) The ~~safety~~ demonstration of compliance of a Type IP-2 or Type IP-3 package design is required to be accomplished in accordance with para. 701 of the Transport Regulations by any of the following methods or by a combination thereof:
 - (i) The results of physical testing of prototypes or models of appropriate scale;
 - (ii) Reference to previous satisfactory demonstrations of a sufficiently similar nature. Test results of designs similar to the design under consideration are permissible if the similarity can be demonstrated sufficiently by justification and validation;
 - (iii) Calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions should be clearly stated and fully justified, including by physical testing if applicable.

~~Additional~~ Further recommendations are provided in paras 701.1–701.25 of SSG-26 (Rev. 1) [2]. No regulatory testing is required for Type IP-1 packages.

APPENDIX II – INDUSTRIAL PACKAGES

The methods or the standards used in each analysis ~~that is~~ specified in items 2.1 ~~to~~ 2.5 of the PDSR should include a description of the analysis technique used, the limitations and accuracy of this technique and ~~the~~ demonstration of the correct application of the technique for the analysis of the package design.

If computer codes are used for the safety analysis, ~~then~~ additional information should be included in the PDSR to ~~justify~~ demonstrate that the code is verified and validated for the specific field of use. The justification for the applicability of these codes should include a statement of possible sources of ~~error~~ error and/or ~~uncertainties~~ uncertainty relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications, as well as of any other parameter influencing the calculated results. ~~This may include and a~~ sensitivity analysis.

- (d) The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions to be fulfilled by different components of the package design comply with the regulatory requirements. Other hazards (e.g. corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes) should be analysed, as necessary, if they have a consequential effect on the safety functions of the package.
- (e) The results of the technical analyses should be compared with the acceptance criteria, and package design assumptions and regulatory compliance should be justified accordingly.

II.7. The following items listed in ~~Figure~~ Fig. 1 and para. 2.43 of this Safety Guide, are not relevant to and not needed for industrial packages, and, therefore, ~~are~~ not included in Table 2:

— Part 1

- Conditions for technical analyses;
- Package illustration.

— Part 2

- Other analyses.

TABLE 2. ~~PDSR~~ PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

TABLE OF CONTENTS OF THE PACKAGE DESIGN SAFETY REPORT (PDSR)
The contents of the PDSR, Part 1 and Part 2, should be listed here, including the revision number of each individual document included in the PDSR.
Part 1
1.1. ADMINISTRATIVE INFORMATION
The following administrative information should be provided: (a) Colloquial name of the package, if applicable; (b) Identification of the package designer (e.g. name, address, contact details); (c) Type of industrial package (i.e. Type IP-1, Type IP-2 or Type IP-3); (d) For package types IP-2 and IP-3, packaging and/or package design identification and restrictions in on packaging serial number(s), if applicable; (e) Modes of transport for which the package is designed, and any operational restrictions associated with the any mode of transport;

TABLE 2. ~~PDSR~~PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

<p>(f) Reference to applicable regulations for the specific package design, including the edition of the IAEA Transport Regulations to which the package design is referring.</p>
<p>1.2. SPECIFICATION OF THE CONTENTS</p>
<p>A detailed description of the permitted contents of the package design should be provided by, stating, — at a minimum, — the following information, as applicable:</p> <p>(a) The general nature of contents (e.g. fresh fuel, contaminated tools, waste);</p> <p>(b) The physical and chemical state, geometric shape, arrangement, material specifications. For industrial packages, the limits of contents depend on the physical state of the radioactive content;</p> <p><u>(b) The nuclides and/or nuclide composition, including progeny radionuclides.</u></p> <p>(c) The A_1 and A_2 values of the radionuclides to be carried in the package. The A_1 and A_2 values for radionuclides that are not listed in Table 2 of the Transport Regulations are required to be determined in accordance with paras 403 — 407 of the Transport Regulations and may be subject to multilateral approval in accordance with para. 403 of the Transport Regulations.</p> <p>(d) The nuclides and/or nuclide composition, including progeny radionuclides;</p> <p><u>(d) The physical and chemical state, geometric shape, arrangement, and material specifications. For industrial packages, the limits of the contents depend on the physical state of the radioactive content.</u></p> <p>(e) The type and characteristics of the radiation emitted by the contents of the package;</p> <p>(f) Limitations on activity, mass and activity concentrations, and heterogeneities in the distribution of the nuclides. The contents should be classified appropriately in one of the categories of <u>low specific activity (LSA)</u> material or <u>surface contaminated object (SCO)</u>, as appropriate, in accordance with paras 409 and 413 of the Transport Regulations. Limitations in specific activity (Bq/g) and surface contamination (Bq/cm²) may be required. Conveyance activity limits in accordance with table 6 of the Transport Regulations should also be taken into account to limit the activity of a single package, if applicable;</p> <p>(g) The mass of fissile material, the nuclides and the enrichment of the contents (see also Appendix V, if necessary);</p> <p>(h) Other dangerous properties of the contents. In accordance with para. 618 of the Transport Regulations, any other dangerous properties (subsidiary hazards) of the contents of the package are required to be taken into account in the package design to be in compliance with the relevant transport regulations for dangerous goods. Additional information on the design requirements for dangerous goods in accordance with the subsidiary hazard can be found in Ref. [chapter 3], Chapter 3.3, Special Provision 172, of Ref. [3].</p> <p>(i) Other limitations to the contents (e.g. moisture, presence of acid). Safety relevant limits for non-radioactive materials should be stated, — for example, limits in terms of material composition, density, form, location within the package, or restrictions on relative quantities of materials — <u>should be stated.</u></p>
<p>1.3. SPECIFICATION OF THE PACKAGING</p>
<p>The packaging design should be defined to the extent necessary to demonstrate compliance with the Transport Regulations, including; the following information <u>should be included</u>, as applicable:</p>

TABLE 2. PDSR PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

- (a) Design drawings;
- (b) The overall dimensions, the maximum mass of the package, when fully loaded, and the mass of the empty packaging;
- (c) A list of all packaging components important to safety and their materials. For Type IP-2 and Type IP-3 packages, the material specifications of the packaging components should also be included;
- (d) The maximum normal operating pressure (particularly in the case of air transport).

For Type IP-3 packages, the specification of the packaging should include a description of the following:

- (1) The packaging body, lid (e.g. closure mechanism and tamper-indicating features), internal arrangements, and components for lifting and tie-down;
- (2) The protection against corrosion;
- (3) The protection against contamination;
- (4) The packaging components required for shielding;
- (5) The shock absorbing components;
- (6) Testing specifications and controls before first use to transport radioactive material ~~and acceptance tests to ensure. This ensures~~ compliance of the fabrication ~~to with~~ the design ~~and allows acceptance of the specimen before first use. See also para. 501 of the Transport Regulations.~~

Note—For radioactive material ~~having that has~~ other dangerous properties, see para. 4.1.9.1.5 of Ref. [3]. The packing ~~instruction~~instructions or tank ~~instruction~~instructions as specified in Ref. [3] (or in the applicable regulations for the carriage of dangerous goods) appropriate to the other dangerous properties of the radioactive material should be complied with, with the exception of industrial packages containing 0.1 kg or more of uranium hexafluoride.

1.4. AGEING CONSIDERATIONS

Depending on the package design, the information relating to ~~the~~ ageing considerations ~~expected in this section of the PDSR, can~~ also be provided by the package designer directly in the table mentioned in item 1.5.

For ~~packagings~~packaging used once for a single transport and not intended for shipment after storage, this ~~section~~item of the PDSR should be left blank.

For all other ~~packagings~~packaging, this ~~section~~item of the PDSR should include the following information:

- (a) The intended conditions of use of the package that might influence ageing;
- (b) The potential ageing mechanisms ~~that are~~ relevant to the package design, taking into account the intended conditions of use of the package;
- (c) Operational ~~activities~~measures (including maintenance and inspection activities before shipment) to monitor and limit the ageing effects;
- (d) Analysis of the influence of ~~the~~ ageing of ~~the~~ packaging and contents on the design assumptions for demonstration of compliance with the regulations, including the technical analyses in Part 2 of the PDSR, considering the specified intended use conditions, ageing mechanisms and operational measures.

~~More~~Further recommendations are provided in paras 613A.1 ~~to~~ –613A.5 of SSG-26 (Rev. 1) [2].

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TABLE 2. PDSR PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

1.5. COMPLIANCE WITH REGULATORY REQUIREMENTS
<p>The PDSR should include a complete list of all paragraphs of the international regulations [1, 3] <u>Transport Regulations</u> and other international or national regulations applicable to the respective package design.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be done using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for industrial packages are provided in a matrix in Annex I.</p>
1.6. PACKAGE OPERATIONS
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p> <ul style="list-style-type: none">(a) Assembling <u>Assembly</u> of the packaging components. This information should not be included for Type IP-1 packages. Type IP-3 packages are required to comply with para. 637 of the Transport Regulations;(b) Loading and unloading of the package contents;(c) Testing and controls before each shipment;(d) Handling and tie-down. Specifications on bolt torqueing, torquing and number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included, if applicable;(e) Any proposed supplementary equipment and operational controls to be applied during transport and, if applicable, during storage before transport, including those that might influence ageing mechanisms. <p>In addition to the radioactive properties, any other dangerous properties of the contents of the package are required to be taken into account (see para. 507 of the Transport Regulations).</p> <p>If written procedures with a detailed description of these activities are available, then reference should be made to these procedures.</p>
1.7. MAINTENANCE
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p> <ul style="list-style-type: none">(a) Maintenance and inspection before each shipment;(b) Maintenance and inspection at periodic intervals throughout the lifetime use of the packaging and/or package. <p>When developing the packaging and/or package maintenance specifications for maintenance to be included in this section <u>item</u> of the PDSR, the following points should be taken into account:</p> <ul style="list-style-type: none">(1) Ageing mechanisms during storage <u>should be considered</u>, when applicable.(2) For single use packages, periodic maintenance does not need to be considered.(3) If written procedures with details of the package maintenance activities are available, then reference <u>should be made</u> to these procedures should be made.
1.8. GAP ANALYSIS PROGRAMME
<p>For packages that are to be used for shipment after storage, the PDSR should include a gap analysis programme describing a systematic procedure for periodic evaluation of changes of regulations,</p>

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changes in technical knowledge and changes of <u>in</u> the state of the package design during storage (see also paras 613A.5, 809.3 and 809.4 of SSG-26 (Rev. 1) [2] and Ref. [78]).
1.9. MANAGEMENT SYSTEM
<p>The PDSR should include the specification of<u>specify</u> the management system that is established and implemented by the package designer, as required in <u>accordance with</u> para. 306 of the Transport Regulations, to demonstrate compliance with the relevant provisions of the Transport Regulations.</p> <p>The management system should be commensurate with the complexity of the package design and should include a reliable document control system.</p> <p>More<u>Further</u> recommendations on the management system for transport are provided in TS-G-1.4 [6].</p>
Part 2
2.1. STRUCTURAL ANALYSIS
<p>The results of the assessment of the mechanical behaviour (including, as applicable, analysis of fatigue, brittle fracture and creep) for routine conditions of transport for all industrial packages and for normal conditions of transport for Type IP-2 and Type IP-3 packages should consider<u>include</u> the following:</p> <ul style="list-style-type: none">(a) The components of the containment system. This is required for Type IP-1 packages only when transported by air (see paras 619 to <u>–</u> 621 of the Transport Regulations);(b) The package components that provide radiation shielding. This is not required for Type IP-1 packages;(c) Any other package components (e.g. shock absorbing components) whose performance may have a consequential effect upon (a) and (b) above. This is not applicable to Type IP-1 packages.(d) The lifting attachments (see paras 608 and 609 of the Transport Regulations).(e) The packaging attachments used for restraining to restrain the package to<u>within</u> its conveyance for routine conditions of transport. <p>If the package is to be transported by air (<u>see</u> paras 619 to <u>–</u> 621 of the Transport Regulations), the structural analysis of the containment system should take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport, as well as the specific temperature and pressure requirements for air transport. Further recommendations are provided in paras 621.2 and 621.3 of SSG-26 (Rev. 1) [2].</p> <p>Attention should be paid to ensure<u>ensuring</u> that any nuts, bolts and other retention devices keep<u>maintain</u> their safety functions during routine conditions of transport, even after repeated use. Further recommendations are provided in para. 613.1 of SSG-26 (Rev. 1) [2].</p> <p>When performing the structural analysis for industrial packages, except for a Type IP-2 or a Type IP-3 package meeting the alternative requirements in one of the paras 626 to <u>626–630 of the Transport Regulations</u>, the following points should be considered:</p> <ul style="list-style-type: none">(1) General considerations:<ul style="list-style-type: none">(i) The mechanical properties of the materials considered in the safety demonstration should be representative of the range of mechanical properties of the package components considering, <u>with account taken of</u> the temperatures likely to be encountered during routine conditions of transport (see para. 616 of the Transport Regulations);

TABLE 2. PDSR PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

<ul style="list-style-type: none"> (ii) The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material (e.g. wood, polymers, plaster, concrete) with temperatures likely to be encountered during routine conditions of transport should be analysed; (iii) The safety against brittle fracture at temperatures likely to be encountered during routine conditions of transport of components of the containment system made of potentially brittle materials (e.g. ferritic steels, cast iron) should be analysed, if necessary; (iv) The strength of lid bolts should be verified for all drop orientations; (v) The internal components (e.g. content, basket, cage) should be verified <u>assessed</u> to ensure <u>verify</u> that they are not liable to damage the containment system; (vi) The condition of the containment system should be determined <u>assessed</u> to demonstrate compliance with the requirements of specifications in item 2.3 of the PDSR for the temperature range likely to be encountered during routine conditions of transport; (vii) Phenomena such as radiolysis, internal pressure elevation, internal inflammation or explosion, physical changes and chemical reactions should be considered when analysing the maximum pressure. <p>(2) Considerations for experimental mechanical testing:</p> <ul style="list-style-type: none"> (i) The package orientations should be determined in accordance with para- paras 722.4 and 722.6 of SSG-26 (Rev. 1) [2]. The orientations should maximize the loading of the package (such as in terms of stress, strain, acceleration and deformation), with consideration of the different package components (e.g. cask body, lid system, shock absorber) and of the protection objectives (i.e. containment and shielding); (ii) For reduced scale models, geometry and material properties similar to the original design, or conservative geometry and material properties, should be used; (iii) The results of the drop test with reduced scale models should be assessed to guarantee that they cover, or are transferable to, the original design; (iv) The representativeness of drop tests performed with reduced scale models should be demonstrated. (v) The experimental mechanical tests should be conducted and reported in accordance with the management system. The test report should address the verification of the package before testing, the description of the test site, the equipment used for the measurements and its calibration data, and the results of the measurements performed. This report should also contain pictures showing and explaining the conditions under which the tests were performed and their results. <p>(3) Considerations for calculations:</p> <ul style="list-style-type: none"> (i) See point (2)(i) above; (ii) Validated computer codes should be used. Input parameters (e.g. material laws, characteristic values, boundary conditions) should describe sufficiently and precisely the real technical and/or physical problems, and the use of these parameters should be justified; (iii) If uncertainties exist regarding important input parameters (e.g. material laws), conservative design calculations <u>—</u> including the possible range of material properties <u>—</u> should be performed; (iv) Data used (e.g. material laws, boundary conditions, load assumptions) and calculation results should be documented comprehensively.
<p>2.2. THERMAL ANALYSIS</p>
<p>The range of temperatures to be considered for the components of the package for demonstration of compliance is the range of temperatures likely to be encountered in routine conditions of transport for</p>

~~APPENDIX II – INDUSTRIAL PACKAGES~~

TABLE 2. ~~PDSR~~PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

Type IP-1 and Type IP-2 packages. For Type IP-3 packages, the range of temperatures to be considered is specified in para. 639 of the Transport Regulations.
2.3. CONTAINMENT DESIGN ANALYSIS
<p>The analysis of the containment design should demonstrate compliance with the requirements for preventing the loss or dispersal of radioactive material for routine conditions of transport for all industrial packages and with the requirements for normal conditions of transport for Type IP-2 and Type IP-3 packages.</p> <p>Containment design analysis is not needed if the structural analysis has shown<u>demonstrated</u> the integrity of the containment boundary, as applicable, for the conditions<u>condition</u> described in para. 645 of the Transport Regulations for reduction of ambient pressure and para. 621 of the Transport Regulations for increase of pressure differential.</p>
2.4. DOSE RATE ANALYSIS
<p>For<u>When</u> performing the dose rate analysis, the following points should be considered:</p> <ul style="list-style-type: none">(a) The dose rates for routine conditions of transport for all types of industrial packages<u>package</u> and a dose rate increase factor for normal conditions of transport for Type IP-2 and Type IP-3 packages should be assessed to demonstrate compliance with the requirements of the Transport Regulations.(b) The dose rate analysis should be based on assuming the maximum radioactive content of the package or such a<u>content</u> for an industrial package that<u>as</u> would create the maximum dose rate at the surface of the package and at specific distances from the surface of the package, as defined in the Transport Regulations.(c) The dose rate analysis should take into account the most recent ICRP<u>International Commission on Radiological Protection</u> recommendations on nuclear decay data for dosimetric calculations (see,<u>see,</u> e.g. see,<u>see,</u> Ref. [97]).<u>(d)</u> The maximum dose rate and a dose rate increase factor for normal conditions of transport, if applicable in accordance with para.<u>paras</u> 523.6 and 624.4 of SSG-26 (Rev. 1) [2], should be determined, taking into account potential amplifying phenomena, such as internal movement of the contents (for instance, e.g.<u>due to deficiencies of the retention system inside the package in the case of transport of contaminated tools</u>), or, in<u>in</u> the case of packages containing liquids, change<u>change</u> in the state of the contents, including segregation and precipitation of the radionuclides. <p>The following remarks should be taken into account when analysing the points listed above:</p> <ul style="list-style-type: none">(d)<u>(1)</u> Dose rate analysis should be based on the maximum radioactive contents of the package design, which should be defined by various methods and parameters, such as nuclide specific activities and source terms for gamma and neutron emitters.(e)<u>(2)</u> The dose rate limits can be shown to be met by calculations or measurements. If calculation methods are used, the calculations of source terms should take into account the interactions, secondary emissions and neutron multiplication factors, when relevant<u>when relevant</u>. If dose rate measurements are used, the source used for the measurements should be representative of the radioactive contents specified in the package design.(f)<u>(3)</u> All calculational<u>calculation</u> methods used for dose rate analysis should be verified and validated for the specific conditions of the package design they are applied to.
2.5. CRITICALITY SAFETY ANALYSIS

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TABLE 2. ~~PDSR~~PACKAGE DESIGN SAFETY REPORT FOR INDUSTRIAL PACKAGES

See Appendix V.

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APPENDIX III TYPE A PACKAGES

III.1. This appendix provides specific recommendations on the information that should be included in Parts 1 and 2 of the PDSR for Type A packages. Table 3 lists each item of the PDSR, with applicable information and guidance. Further recommendations on Type A packages are provided in SSG-26 (Rev. 1) [2].

III.2. In accordance with para. 801 of the Transport Regulations, Type A packages require a ~~PDS~~ PDSR.

III.3. For packages containing fissile nuclides, in addition to the recommendations of this appendix, see also Appendix V.

III.34. For packages containing 0.1 kg or more of uranium hexafluoride, in addition to the recommendations of this appendix, see also Appendix VI.

III.45. For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.5 of the PDSR or, if necessary, in Part 2 of the PDSR.

III.56. For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely identified by precisely indicating a drawing of the packaging (see item 1.3 of the PDSR), including its revision number, and the specification of the contents (see item 1.2 of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry or performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design ~~specifications~~ specifications provided in items 1.2 and 1.3 of the PDSR or to other assumptions derived from the design specifications and used in the technical analyses. All mechanical, thermal and shielding characteristics of each component of the package and the acceptance criteria used in technical analyses should be defined.
- (c) The ~~safety~~ demonstration of compliance of a Type A package design is required to be accomplished in accordance with para. 701 of the Transport Regulations by any of the following methods or by a combination thereof:
 - (i) The results of physical testing of prototypes or models of appropriate scale;
 - (ii) Reference to previous satisfactory demonstrations of a sufficiently similar nature. Test results of designs similar to the design under consideration are permissible if the similarity can be demonstrated sufficiently by justification and validation;
 - (iii) Calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions should be clearly stated and fully justified, including by physical testing if applicable.

~~Additional~~ Further recommendations are provided in paras 701.1–701.25 of SSG-26 (Rev. 1) [2].

The methods or the standards used in each analysis specified in items 2.1 ~~to~~ 2.5 of the PDSR should include a description of the analysis technique used, the limitations and accuracy of this

APPENDIX III – TYPE A PACKAGES

technique and ~~the~~ demonstration of the correct application of the technique for the analysis of the package design.

If computer codes are used for the safety analysis, ~~then~~ additional information should be included in the PDSR to ~~justify~~ ~~demonstrate~~ that the code is verified and validated for the ~~specified~~ ~~specific~~ field of use. The justification for the applicability of these codes should include a statement of possible sources of ~~error~~ ~~error~~ and/or ~~uncertainties~~ ~~uncertainty~~ relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications, as well as of any other parameter influencing the calculated results. ~~This may include and a~~ sensitivity analysis.

- (d) The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions, to be fulfilled by different components of the package design, comply with the regulatory requirements. Other hazards ~~that may have a consequential effect on the safety functions should be analysed. This may concern~~ (e.g. corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes) should be analysed, as necessary, if they have a consequential effect on the safety functions of the package.
- (e) The results of the technical analyses should be compared with the acceptance criteria, and package design assumptions and regulatory compliance should be justified accordingly.

III.67. The following items listed in ~~Figure~~ ~~Fig.~~ 1 and para. 2.3 of this Safety Guide are not relevant to and not needed for Type A packages and, therefore, are not included in Table 3:

- Part 1:
 - Conditions for technical analyses.
- Part 2:
 - Other analyses.

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

TABLE OF CONTENTS OF THE <u>PACKAGE DESIGN SAFETY REPORT (PDSR)</u>
The contents of the PDSR, Part 1 and Part 2, should be listed here, including the revision number of each individual document included in the PDSR.
Part 1
1.1. ADMINISTRATIVE INFORMATION
The following administrative information should be provided: <ul style="list-style-type: none">(a) Colloquial name of the package, if applicable;(b) Identification of the package designer (<u>e.g.</u> name, address, contact details);(c) Type of package;(d) Packaging and/or package design identification and restrictions in on packaging serial number(s), if applicable;(e) Modes of transport for which the package is designed, and any operational restrictions associated with the any mode of transport;(f) Reference to the applicable regulations for the specific package design, including the edition of the Transport Regulations to which the package design is referring.

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>1.2. SPECIFICATION OF THE CONTENTS</p>
<p>A detailed description of the permitted contents of the package design should be provided by, stating — at a minimum, — the following information, as applicable:</p> <ul style="list-style-type: none"> (a) The general nature of contents (e.g. irradiated fuel, metallurgical specimens, radiographic source); (b) The nuclides and/or nuclide composition, including progeny radionuclides; (c) The A_1 and A_2 values of the radionuclide radionuclides to be carried in the package. The A_1 and A_2 values for radionuclides that are not listed in Table table 2 of the Transport Regulations are required to be determined in accordance with paras 403 — 407 of the Transport Regulations and may be subject to multilateral approval in accordance with para. 403 of the Transport Regulations. (d) The physical and chemical state (additional design specifications are applicable to liquid and gas contents), geometric shape, arrangement, irradiation parameters, and material specifications; (e) The type and characteristics of the radiation emitted by the contents of the package; (f) Limitations on activity, mass and activity concentrations, and heterogeneities in the distribution of the nuclides. Compliance is required with the activity limits for Type A packages in accordance with paras 429 — and 430 of the Transport Regulations is required; (g) A valid certificate for special form radioactive material or low dispersible radioactive material, when such material is included in the package; (h) The mass of fissile material, the nuclides and the enrichment of the contents (see also Appendix V); (i) Other dangerous properties of the contents. In accordance with para. 618 of the Transport Regulations, any other dangerous properties (subsidiary hazards) of the contents of the package are required to be taken into account in the package design to be in compliance with the relevant transport regulations for dangerous goods. Additional information on design requirements for dangerous goods in accordance with the subsidiary hazard can be found in Ref. [chapter 3], Chapter. 3-3, Special Provision 172; of Ref. [3]. (j) Other limitations to on the contents (e.g. moisture, presence of acid). Safety relevant limits for non-radioactive materials (e.g. materials subject to radiolysis) should be stated, — for example, limits in terms of material composition, density, form, or location within the package, or restrictions o on relative quantities of materials — should be stated.
<p>1.3. SPECIFICATION OF THE PACKAGING</p>
<p>The packaging design should be defined to the extent necessary to demonstrate compliance with the Transport Regulations, including; the following information should be included, as applicable:</p> <ul style="list-style-type: none"> (a) Design drawings; (b) The overall dimensions, the maximum mass of the package, when fully loaded, and the mass of the empty packaging; (c) A list of all packaging components important to safety and their materials, including the material specifications of the packaging components; (d) The maximum normal operating pressure (particularly in the case of air transport). (e) A description of the packaging body, lid (e.g. closure mechanism and tamper-indicating features), internal arrangements, and components for lifting and tie-down; (f) A description of the protection against corrosion; (g) A description of the protection against contamination;

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>(h) A description of the packaging components of the containment system, including the definition of the containment boundary and the special features for liquid (see para. 650 of the Transport Regulations). This may be supported by special <u>Special</u> form radioactive material <u>may be a component of the containment system in accordance with para. 642 of the Transport Regulations</u>, if applicable (see also item 1.2-(g) of the PDSR);.</p> <p>(i) A description of the packaging components required for shielding;.</p> <p>(j) A description of the shock absorbing components;.</p> <p>(k) Testing specifications and controls before first use to transport radioactive material. This ensures compliance of the fabrication to <u>with</u> the design and allows acceptance of the specimen before its first use. See also para. 501 of the Transport Regulations.</p> <p>Note—For radioactive material having that has other dangerous properties, see <u>para. 4.1.9.1.5</u> of Ref. [3]. The packing instruction <u>instructions</u> as specified in Ref. [3] (or in the applicable regulations for the carriage of dangerous goods) appropriate to the other dangerous properties of the radioactive material should be complied with, with the exception of packages containing 0.1 kg or more of uranium hexafluoride.</p>
<p>1.4. AGEING CONSIDERATIONS</p>
<p>Depending on the package design, the information relating to the ageing considerations, expected in this section of the PDSR, can <u>can also</u> be provided by the package designer directly in the table mentioned in item 1.5.</p> <p>For packagings <u>packaging</u> used once for a single transport and not intended for shipment after storage, this section <u>item of the PDSR</u> should be left blank.</p> <p>For all other packagings <u>packaging</u>, this section <u>item</u> of the PDSR should include the following information:</p> <p>(a) The intended conditions of use of the package that might influence ageing;</p> <p>(b) The potential ageing mechanisms that are relevant to the package design, taking into account the intended conditions of use of the package;</p> <p>(c) Operational measures (including maintenance and inspection activities before shipment) to monitor and limit the ageing effects;</p> <p>(d) Analysis of the influence of the ageing of <u>the</u> packaging and contents on the design assumptions for demonstration of compliance with the regulations, including the technical analyses in Part 2 of the PDSR, considering the specified intended use conditions, ageing mechanisms and operational measures.</p> <p>Further recommendations are provided in paras 613A.1 to <u>613A.5</u> of SSG-26 (Rev. 1) [2].</p>
<p>1.5. COMPLIANCE WITH REGULATORY REQUIREMENTS</p>
<p>The PDSR should include a complete list of all paragraphs of the Transport Regulations and other international or national regulations applicable to the respective package design.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be done using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for Type A packages are provided in a matrix in Annex I.</p>

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>1.6. PACKAGE OPERATIONS</p>
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p> <ul style="list-style-type: none"> (a) Assembling <u>Assembly</u> of the packaging components, including demonstration of compliance with para. 637 of the Transport Regulations; (b) Loading and unloading of the package contents; (c) Testing and controls before each shipment. The methods used for operational controls and tests, in particular those required in accordance with paras 502, 503-(a), 508, 523, 526, 527 and <u>526–528</u> of the Transport Regulations, should be detailed; (d) Handling and tie-down. Specifications on bolt torqueing, torquing and number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included, if applicable; (e) Any proposed supplementary equipment and operational controls to be applied during transport. <p>In addition to the radioactive properties, any other dangerous properties of the contents of the package are required to be taken into account (see para. 507 of the Transport Regulations).</p> <p>If written procedures with a detailed description of these activities are available, then reference should be made to these procedures.</p>
<p>1.7. MAINTENANCE</p>
<p>The minimum specifications for the following activities should be fully defined, as applicable:</p> <ul style="list-style-type: none"> (a) Maintenance and inspection before each shipment; (b) Maintenance and inspection at periodic intervals throughout the lifetime use of the packaging and/or package. <p>When developing the maintenance specifications to be included in this section <u>item</u> of the PDSR, the following points should be taken into account:</p> <ul style="list-style-type: none"> (1) Ageing mechanisms during storage <u>should be considered</u>, when applicable. (2) For single use packages, periodic maintenance does not need to be considered. (3) If written procedures with details of the package maintenance are available, then reference should be made to these procedures.
<p>1.8. GAP ANALYSIS PROGRAMME</p>
<p>For packages that are to be used for shipment after storage, the PDSR should include a gap analysis programme describing a systematic procedure for periodic evaluation of changes of regulations, changes in technical knowledge and changes of <u>in</u> the state of the package design during storage (see also paras 613A.5, 809.3 and 809.4 of SSG-26 (Rev. 1) [2] and Ref. [78]).</p>
<p>1.9. MANAGEMENT SYSTEM</p>
<p>The PDSR should include the specification of <u>specify</u> the management system that is established and implemented by the package designer as required, in <u>accordance with</u> para. 306 of the Transport Regulations, to demonstrate compliance with the relevant provisions of the Transport Regulations.</p> <p>The management system should be commensurate with the complexity of the package design and should include a reliable document control system.</p>

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>More<u>Further</u> recommendations on the management system for transport are provided in TS-G-1.4 [6].</p>
<p>1.10. PACKAGE ILLUSTRATION</p> <p>A reproducible illustration should be provided showing the make-up of the package, including shock absorbers and internal arrangements, if applicable.</p> <p>The illustration should indicate at least the overall outside dimensions and the mass of the package when empty and when loaded.</p>
<p>Part 2</p>
<p>2.1. STRUCTURAL ANALYSIS</p> <p>The results of the assessment of the mechanical behaviour (including, as applicable, analysis of fatigue, brittle fracture and creep) for routine and normal conditions of transport should consider<u>include</u> the following:</p> <ul style="list-style-type: none"> (a) The components of the containment system. This may include special form radioactive material, if applicable, as established in para. 642 of the Transport Regulations;. (b) The package components that provide radiation shielding;. (c) Any other package components (e.g. shock absorbing components) whose performance may have a consequential effect upon (a) and/or (b) above. (d) The lifting attachments (see paras 608 and 609 of the Transport Regulations);. (e) The packaging attachments used for restraining to restrain the package to within its conveyance for routine conditions of transport. <p>If the package is to be transported by air (see paras 619 to 621 of the Transport Regulations), the structural analysis of the containment system should take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport as well as the specific temperature and pressure requirements for air transport. Further recommendations are provided in paras 613.1 and 621.2 of SSG-26 (Rev. 1) [2].</p> <p>Attention should be paid to ensure<u>ensuring</u> that any nuts, bolts and other retention devices keep<u>maintain</u> their safety functions during routine conditions of transport, even after repeated use. Further recommendations are provided in para. 613.1 of SSG-26 (Rev. 1) [2].</p> <p>When performing the structural analysis for Type A packages, the following points should be taken into account<u>considered</u>:</p> <ul style="list-style-type: none"> (1) General considerations: <ul style="list-style-type: none"> (i) The mechanical properties of the materials considered in the safety demonstration should be representative of the range of mechanical properties of the package components and should consider, with account taken of the temperatures likely to be encountered during routine conditions of transport (see para. 639 of the Transport Regulations);. (ii) The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material (e.g. wood, polymers, plaster, concrete) with temperatures likely to be encountered during routine conditions of transport should be analysed;. (iii) The safety against brittle fracture at temperatures likely to be encountered during routine conditions of transport of components of the containment system made of potentially brittle materials (e.g. ferritic steels, cast iron) should be analysed, if necessary;. (iv) The strength of lid bolts should be verified for all drop orientations;.

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>(v) The internal components (e.g. content, basket, cage) should be verified<u>assessed</u> to ensure<u>verify</u> that they are not liable to damage the containment system;.</p> <p>(vi) The condition of the containment system should be determined<u>assessed</u> to demonstrate compliance with the specifications in item 2.37 of the PDSR for the temperature range likely to be encountered during routine conditions of transport;.</p> <p>(vii) Phenomena such as radiolysis, internal pressure elevation, internal inflammation or explosion, physical changes and chemical reactions should be considered when analysing the maximum pressure.</p> <p>(2) Considerations for experimental mechanical testing:</p> <p>(i) The package orientations should be determined in accordance with paras 722.4 and 722.6 of SSG-26 (Rev. 1) [2]. The orientations should maximize the loading of the package (in terms of stress, strain, acceleration and deformation));, with consideration of the different package components (e.g. cask body, lid system, shock absorber) and of the protection objectives (<u>i.e.</u> containment and shielding));.</p> <p>(ii) For reduced scale models, geometry and material properties similar to the original design, or conservative geometry and material properties, should be used;.</p> <p>(iii) The results of the drop test with reduced scale models should be assessed to guarantee that they cover, or are transferable to, the original design;.</p> <p>(iv) The representativeness of drop tests performed with reduced scale models should be demonstrated.</p> <p>(v) The experimental mechanical tests should be conducted and reported in accordance with the management system. The test report should address the verification of the package before testing, the description of the test site, the equipment used for measurements and its calibration data, and the results of the measurements performed. This report should also contain pictures showing and explaining the performing conditions of<u>under which</u> the tests were performed and their results.</p> <p>(3) Considerations for calculations:</p> <p>(i) See point (2)-(i) above;.</p> <p>(ii) Validated computer codes should be used. Input parameters (e.g. material laws, characteristic values, boundary conditions) should describe sufficiently and precisely the real technical and/or physical problems, and the use of these parameters should be justified;.</p> <p>(iii) If uncertainties exist regarding important input parameters (e.g. material laws), conservative design calculations — including the possible range of material properties — should be performed;.</p> <p>(iv) Data used (e.g. material laws, boundary conditions, load assumptions) and calculation results should be documented comprehensively.</p>
<p>2.2. THERMAL ANALYSIS</p>
<p>The range of temperatures to be considered for the components of the package for demonstration of compliance is the range of temperatures specified in para. 639 of the Transport Regulations.</p>
<p>2.3. CONTAINMENT DESIGN ANALYSIS</p>
<p>The analysis of the containment design should demonstrate compliance with the requirements for preventing the loss or dispersal of radioactive material for routine and normal conditions of transport for all Type A packages. For Type A packages containing liquids or gases, additional drop tests are</p>

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

required ~~according to the requirements established in~~ accordance with paras 650 and 651 of the Transport Regulations.

Attention should be paid to ~~defined~~ defining precisely the contents of the package, because assumptions and demonstrations for the containment design analysis can vary ~~based~~ depending on the contents.

Where special form radioactive material constitutes part of the containment system, consideration should be given to the appropriate performance of the special form radioactive material for routine and normal conditions of transport.

Containment analysis is not needed if the structural analysis has ~~shown~~ demonstrated the integrity of the containment boundary, as applicable, ~~according to~~ for the ~~requirements established~~ condition described in para. 645 of the Transport Regulations for reduction of ambient pressure and para. 621 of the Transport Regulations for increase of pressure differential.

2.4. DOSE RATE ANALYSIS

~~For~~ When performing the dose rate analysis, the following points should be considered:

(a) The dose rates for routine conditions of transport and a dose rate increase factor for normal conditions of transport should be assessed to demonstrate compliance with the requirements of the Transport Regulations.

~~(1)~~(b) The dose rate analysis should be based on assuming the maximum radioactive content of the package or such a content for a Type A package ~~that~~ as would create the maximum dose rate at the surface of the package and at specific distances from the surface of the package, as defined in the Transport Regulations.

~~(b)~~(c) The dose rate analysis should take into account the most recent ~~ICRP~~ International Commission on Radiological Protection recommendations on nuclear decay data for dosimetric calculations (see, e.g. ~~see~~, Ref ~~9~~. [7]).

~~(2)~~(d) The maximum dose rate and a dose rate increase factor for normal conditions of transport, if applicable in accordance with paras 523.6 and 624.4 of SSG-26 (Rev. 1) [2], should be determined, taking into account potential amplifying phenomena, such as internal movement of the contents (~~for instance, e.g.~~ due to deficiencies of the retention system inside the package in ~~the~~ case of transport of contaminated tools), or, ~~—~~ in the case of packages containing liquids, ~~—~~ change in the state of the contents, including segregation and precipitation of the radionuclides.

The following ~~remarks~~ should be taken into account when analysing the points listed above:

~~(3)~~(1) Dose rate analysis should be based on the maximum radioactive contents of the package design, which should be defined by various methods and parameters, such as nuclide specific activities and source terms for gamma and neutron emitters;.

~~(4)~~(2) The dose rate limits can be shown to be met by calculations or measurements. If calculation methods are used, the calculations of the source terms should take into account the interactions, secondary emissions and neutron multiplication factors, when relevant. If dose rate measurements are used ~~in the analysis~~, the source used for the measurements should be representative of the radioactive contents specified in the package design;.

~~(5)~~(3) Dose rate analysis should be performed in such a way that the ~~areas of the~~ package surface ~~areas~~ with the maximum dose rates are identified and analysed. These ~~package surface~~ areas include trunnion areas, areas containing gaps that allow the radiation to pass without being

TABLE 3. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE A PACKAGES

<p>attenuated, and <u>other</u> areas with the potential <u>effor</u> increased dose rates due to the design of the package;</p> <p>(6)(4) All calculation methods used for dose rate analysis should be verified and validated for the specific conditions of the package design they are applied to;</p> <p>(7)(5) The expected areas for peak dose rates should be specified and checked before shipment;</p> <p>(8)(6) Proof that the sources <u>are maintained will remain</u> secure for drop test sequence conditions in their storage positions (e.g. in <u>an irradiator irradiators</u>) should be provided in the structural analysis, if applicable.</p>
2.5. CRITICALITY SAFETY ANALYSIS
See Appendix V.

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**APPENDIX IV.
TYPE B(U), TYPE B(M) AND TYPE C PACKAGES**

IV.1 This appendix provides specific recommendations on the information that should be included in Parts 1 and 2 of the PDSR for Type B(U), Type B(M) and Type C packages. Table 4 lists each item of the PDSR, with applicable information and guidance. Further recommendations on Type B(U), Type B(M) and Type C packages are provided in SSG-26 (Rev. 1) [2].

IV.2 For packages containing fissile nuclides, in addition to the recommendations ~~of~~in this appendix, see also Appendix V.

IV.3 For packages containing 0.1 kg or more of uranium hexafluoride, in addition to the recommendations ~~of~~in this appendix, see also Appendix VI.

IV.4 For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.6. of the PDSR or, if necessary, in Part 2 of the PDSR.

IV.5 For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely identified by precisely indicating a drawing of the packaging (see item 1.3. of the PDSR), including its revision number, and the specification of the contents (see item 1.2. of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry or performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design ~~specifications~~specifications provided in items 1.2. and 1.3. of the PDSR or to other assumptions derived from the design specifications and used in the technical analyses. All mechanical, thermal and shielding characteristics of each component of the package and ~~the~~ acceptance criteria used in technical analyses should be defined. The design assumptions should take into account ageing mechanisms, as necessary. ~~Additional~~Further recommendations are provided in paras 613A.1 ~~to~~ 613A.4 of SSG-26 (Rev. 1) [2].
- (c) The ~~safety~~ demonstration ~~of compliance~~ of a Type B(U), Type B(M) or Type C package design is required to be accomplished in accordance with para. 701 of the Transport Regulations by any of the following methods or by a combination thereof:
 - ~~(i)~~ The results of physical testing of prototypes or models of appropriate scale;
 - ~~(i)~~ . When a programme for physical testing of prototypes or models of appropriate scale is implemented for a specific package design to be approved by the competent authority, the competent authority should be notified of the programme before the testing and should be allowed to witness the testing.
 - (ii) Reference to previous satisfactory demonstrations of a sufficiently similar nature. Test results of designs similar to the design under consideration are permissible if the similarity can be demonstrated sufficiently by justification and validation;
 - (iii) Calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions should be clearly stated and fully justified, including by physical testing if applicable.

APPENDIX IV – TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

~~Additional~~Further recommendations are provided in paras 701.1–701.25 of SSG-26 (Rev. 1) [2].

The methods or the standards used in each analysis specified in items 2.1 ~~to~~–2.6 of the PDSR should include a description of the analysis technique used, the limitations and accuracy of this technique and ~~the~~a demonstration of the correct application of the technique for the analysis of the package design.

If computer codes are used for the safety analysis, ~~then~~additional information should be included in the PDSR to ~~justify~~demonstrate that the code is verified and validated ~~in its~~for the specific field of use. The justification for the applicability of these codes should include a statement of possible sources of ~~errors~~error and/or ~~uncertainties~~uncertainty relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications, as well as of any other parameter influencing the calculated results. ~~This may include and a~~ sensitivity analysis.

- (d) ~~The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions to be fulfilled by different components of the package design comply with the regulatory requirements. The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions to be fulfilled by different components of the package design comply with the regulatory requirements. Other hazards that may have a consequential effect on the safety functions of the package should be analysed. This may concern (e.g. corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes) should be analysed, as necessary, if they have a consequential effect on the safety functions of the package.~~
- (e) The results of the technical analyses should be compared with the acceptance criteria, and package design assumptions and regulatory compliance should be justified accordingly.

TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

TABLE OF CONTENTS OF THE <u>PACKAGE DESIGN SAFETY REPORT (PDSR)</u>
The contents of the PDSR, Part 1 and Part 2, should be listed here, including the revision number of each individual document included in the PDSR.
Part 1
1.1. ADMINISTRATIVE INFORMATION
The following administrative information should be provided: (a) Colloquial name of the package, if applicable; (b) Identification of the package designer (<u>e.g.</u> name, address, contact details); (c) Type of package; (d) UN number; (e) Packaging and/or package design identification and restrictions in <u>on</u> packaging serial number(s), if applicable;

APPENDIX IV — TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(f) Modes of transport for which the package is designed, and any operational restrictions associated with theany mode of transport;</p> <p>(g) Reference to the applicable regulations for the specific package design, including the edition of the Transport Regulations to which the package design is referring.</p>
<h3>1.2. SPECIFICATION OF THE CONTENTS</h3>
<p>-The description of the contents and of their physical and chemical forms and radionuclides should be sufficiently precise to allow thedemonstration of compliance with the requirements for containment of the radioactive contents, control of the external dose rate and protection of damage caused by heat.</p> <p>The description should include all dimensions (drawings), material characteristics and mechanical properties which are used in demonstrating to demonstrate the required safety performanceperformance.</p> <p>The properties of materials should be given for temperatures ranging from -40°C (or another temperature for Type B(M) packages in accordance with para. 667667 of the Transport Regulations) to the maximum temperature in normal conditions of transport... The properties of materials of components that areexpected to maintain their safety function under the thermal test; should be given for a range of temperaturetemperatures reachable during such a test.</p> <p>The description may include the total numbers of A₁ or A₂ in the contents.</p> <p>There are additional design requirements depending on the activity (see, e.g. see., para. 660 of the Transport Regulations).</p> <p>Compliance with the activity limits for Type B(U) and Type B(M) packages, if transported by air, in accordance with para. 433 of the Transport Regulations; should be considered.</p> <p>A detailed description of the permitted contents of the package design should be providedby; stating; — at a minimum; — the following information, as applicable:</p> <p>(a) The general nature of contents (e.g. irradiated fuel, metallurgical specimens, radiographic source););</p> <p>(b) The nuclides and/or nuclide composition, including progeny radionuclides;;</p> <p>(c) The A₁/and A₂ values of a radionuclidethe radionuclides to be carried in the package. The A₁/and A₂ values for radionuclides that are not listed in Tabletable 2 of the Transport Regulations are required to be determined in accordance with paras 403—407 of the Transport Regulations and may be subject to multilateral approval in accordance with para. 403 of the Transport Regulations.</p> <p>(e)(d) The physical and chemical state, geometric shape, arrangement, irradiation parameters (if applicable, the maximum burnup and minimum cooling time), moisture content; and material specifications;;</p> <p>(e)(e) The type and characteristics of the radiation emitted by the contents of the package;;</p> <p>(e)(f) The limitations inLimitations on activity, mass and concentrations, and heterogeneities in the distribution of the nuclides;;</p> <p>(f)(g) A valid certificate for special form radioactive material or low dispersible radioactive material, when such materials arematerial is included in the package;;</p> <p>(g)(h) Limitations in the heat generation rate of the contents;;</p> <p>(h)(i) The mass of fissile material, the nuclides and the enrichment of the contents (see also Appendix V, if necessary););</p>

APPENDIX IV — TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(j) Other dangerous properties of the contents. In accordance with para. 618 of the Transport Regulations, any other dangerous properties (subsidiary hazards) of the contents of the package are required to be taken into account in the package design to be in compliance with the relevant transport regulations for dangerous goods. Additional information on the design requirements for dangerous goods in accordance with the subsidiary hazard can be found in <u>Ref. [chapter 3], Chapter 3.3, Special Provision 172), of Ref. [3].</u></p> <p>(k) Other limitations on the contents (e.g. moisture, presence of acid). Safety relevant limits for non-radioactive materials (e.g. materials subject to radiolysis) should be stated, for example, limits in <u>terms of</u> material composition, density, form, <u>or</u> location within the package, <u>or</u> restrictions on relative quantities of materials <u>— should be stated.</u></p>
<h3>1.3. SPECIFICATION OF THE PACKAGING</h3>
<p>The packaging design should be defined to the extent necessary to demonstrate compliance with the Transport Regulations, including; the following information <u>should be included,</u> as applicable:</p> <ul style="list-style-type: none">(a) Design drawings;(b) The overall dimensions, the maximum mass of the package, when fully loaded, and the mass of the empty package <u>packaging</u> (additional configurations may be included, depending on the operation <u>operating</u> conditions);(c) A list of packaging components important to safety and their materials, including the specifications and methods of manufacture of the components, specifications for material procurement, welding, other special processes, <u>and</u> non-destructive examination and testing. The properties of materials of components that are expected to maintain their safety function under the thermal test, should be given for a range of temperature reachable during such a test;(d) The maximum normal operating pressure.(e) A description of the packaging body, lid (e.g. closure mechanism and tamper-<u>indicating features</u>) <u>and</u>, internal arrangements, and components for lifting and tie-down;(f) A description of the protection against corrosion;(g) A description of the protection against contamination;(h) A description of the packaging components for heat dissipation;(i) A description of the packaging components of the containment system (<u>including the definition of the containment boundary</u>). This may be supported by special. <u>Special form radioactive material may be a component of the containment system in accordance with para. 642 of the Transport Regulations,</u> if applicable (see also item 1.2.-(f)(g) of the PDSR);(j) A description of the packaging components required for shielding;(k) A description of the shock absorbing components;(l) A description of the packaging components for thermal protection;(m) Testing specifications and controls before first use to transport radioactive material. This ensures compliance of the fabrication to <u>with</u> the design and allows acceptance of the specimen before its first use. See also para. 501 of the Transport Regulations.
<h3>1.4. AGEING CONSIDERATIONS</h3>
<p>Depending on the package design, the information relating to the ageing considerations, expected in this section of the PDSR, can also be provided by the package designer directly in the table mentioned in item 1.6.</p>

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>For packagingspackaging used once for a single transport and not intended for shipment after storage, this sectionitem of the PDSR should be left blank.</p> <p>For all other packagingspackaging, this sectionitem of the PDSR should include the following information:</p> <ul style="list-style-type: none">(a) The intended conditions of use of the package that might influence ageing;(b) The potential ageing mechanisms that are relevant to the package design, taking into account the intended conditions of use of the package;(c) Operational measures (including maintenance and inspection activities before shipment) to monitor and limit the ageing effects;(d) Analysis of the influence of the ageing of the packaging and contents on the design assumptions for demonstration of compliance with the regulations, including the technical analyses in Part 2 of the PDSR, considering the specified intended use conditions, ageing mechanisms and operational measures. <p>MoreFurther recommendations are provided in paras 613A.1 to 613A.5 of SSG-26 (Rev. 1) [2], and additional information on ageing considerations can be found in Ref. [78].</p>
<h3>1.5. CONDITIONS FOR TECHNICAL ANALYSES</h3>
<p>This sectionitem of the PDSR should describe the main design principles and performance characteristics of the package design to meet the different safety requirements (e.g. containment, heat removal, dose rates) of the Transport Regulations.</p> <p>This sectionitem should summarize the analyses performed in Part 2 of the PDSR and describe how analysis assumptions and data used for the safety analysis — especially regarding release of radioactive material and dose rates — are derived from the design and the behaviour of the package for routine, normal and accident conditions of transport, also taking into account ageing mechanisms (see item 1.4. of the PDSR).</p> <p>This sectionitem will help to ensure that the package design and the various parts of the safety demonstration are compatible with one another.</p>
<h3>1.6. COMPLIANCE WITH REGULATORY REQUIREMENTS</h3>
<p>The PDSR should include a complete list of all paragraphs of the Transport Regulations and other international or national regulations applicable to the respective package design.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be done using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for Type B(U), Type B(M) and Type C packages are provided in a matrix in Annex I.</p>
<h3>1.7. PACKAGE OPERATIONS</h3>
<p>The minimum specifications for the following activities should be <u>fully</u> defined, as applicable:</p> <ul style="list-style-type: none">(a) AssemblingAssembly of the packaging components, including demonstration of compliance with the requirements established in para. 637 of the Transport Regulations);.

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

- (b) Loading and unloading of the package contents;
- (c) Testing and controls before each shipment:
- (i) The methods used for operational controls and tests. ~~In, in~~ particular those required in accordance with paras 502, 503, 508, 523, ~~526, 527~~ and ~~526–528~~ of the Transport Regulations, should be detailed;
 - (ii) The measures ~~aiming aimed~~ at preventing the presence of unauthorized objects (e.g. tools, small pieces of plastic, worn gaskets) in the package should be defined;
 - (iii) The control of all void spaces of the package (*i.e.* cavity and other spaces), in particular regarding water penetration, should be specified;
 - (iv) For drying operations, the method used should prevent formation of ice;
 - (v) For ~~leak tightness leaktightness~~ testing, qualified methods should be implemented (see item ~~12.3.~~ of the PDSR). For packages that are or have been in contact with water, it should be demonstrated that the presence of water does not impair the validity of the ~~leak tightness leaktightness~~ testing by sealing the leakage paths;
 - (vi) The absence of defects should be ensured by a specific inspection procedure that has been appropriately qualified;
 - (vii) The control of tightening torques of the bolts and of the correct position of the lid, and the adjustment of the internal atmosphere and pressure, should be specified.
- (d) Handling and tie-down. Specifications on bolt ~~torqueing, torquing and~~ number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included, if applicable;
- (e) Estimation of the correction factor to be applied to the dose rate and the transport index to take into account any amplifying phenomena (paras ~~523.6 and 624.4 and 523.7~~ of SSG-26 (Rev. 1) [~~2~~];).
- (f) Any proposed supplementary equipment and operational controls to be applied during transport and, if applicable, during storage before transport, including those that might influence ageing mechanisms.

In addition to the radioactive properties, any other dangerous properties of the contents of the package ~~should are required to~~ be taken into account (see para. 507 of the Transport Regulations).

If written procedures with a detailed description of these activities are available, then reference should be made to these procedures.

1.8. MAINTENANCE

The minimum specifications for the following activities should be fully defined, as applicable:

- (a) Maintenance and inspection before each shipment;
- (b) Maintenance and inspection at periodic intervals throughout the lifetime use of the packaging and/or package;

Periodic maintenance and inspection activities should be detailed and may include the following activities and tests, depending on the package design:

- (i) (1) Visual inspections and measurements (including tie-down and handling attachments);
- (ii) (2) The control of all void spaces of the package (*i.e.* cavity and other spaces), in particular regarding water penetration;
- (iii) (3) Weld examinations;
- (iv) (4) Structural (including tie-down and handling attachments) and pressure tests;

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(v)(5) Leakage tests;</p> <p>(vi)(6) _____ Component and material tests (screws, bolts, welds, gaskets, seals, wood, foam, resin, etc.);</p> <p>(vii)(7) _____ Shielding tests;</p> <p>(viii)(8) _____ Thermal verification tests.</p> <p>The definition of the specified periodicity of replacement of the packaging components should take into account any reduction in efficiency due to wear, corrosion, ageing and/or change in seal compression with time.</p> <p>The justification of the periodicity of activities, when needed, should be included in this section <u>item of the PDSR</u>.</p> <p>If written procedures with details of the package-maintenance activities are available, then reference should be made to these procedures.</p>
<p>1.9. GAP ANALYSIS PROGRAMME</p>
<p>For packages that are to be used for shipment after storage, the PDSR should include a gap analysis programme describing a systematic procedure for periodic evaluation of changes of regulations, changes in technical knowledge and changes of <u>in</u> the state of the package design during storage (see also paras 613A.5, 809.3 and 809.4 of SSG-26 (Rev. 1) [2] and Ref. [78]).</p>
<p>1.10. MANAGEMENT SYSTEM</p>
<p>The PDSR should include the specification of <u>specify</u> the management system that is established and implemented by the package designer as required, in <u>accordance with</u> para. 306 of the Transport Regulations, to ensure <u>demonstrate</u> compliance with the relevant provisions of the Transport Regulations.</p> <p>The management system should cover the following activities:</p> <ul style="list-style-type: none">(a) Package design, PDSR, documentation, records, and use of computer codes;(b) Manufacture and testing of the packaging;(c) Operation (<u>i.e.</u> preparation, loading, carriage, storage in transit, shipment after storage, unloading and receipt);(d) Maintenance, repair and inspection of the packaging. <p>The management system should be commensurate with the complexity of the package design and should include a reliable document control system.</p> <p>The management system should include descriptions of the actions to be performed to check the compliance with the PDSR of the documents relating to package operation (e.g. manufacture <u>manufacturing</u>, operation or maintenance manual <u>manuals</u>) <u>with the PDSR and should also cover</u> the management of deviations detected in the framework of any transport activity.</p> <p>For all components important to safety, the PDSR should define the parameters to be guaranteed to assure <u>ensure</u> compliance with the package design, and thereby <u>therefore</u> safety, and the level of controls <u>required</u> during manufacturing and maintenance.</p> <p>More <u>Further</u> recommendations on the management system for transport are provided in TS-G-1.4 [6].</p>

APPENDIX IV – TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

1.11. PACKAGE ILLUSTRATION
<p>A reproducible illustration should be provided showing the make-up of the package, including shock absorbers, devices for thermal protection, and internal arrangements, if applicable.</p> <p>The illustration should indicate at least the overall outside dimensions and the mass of the package when empty and when loaded.</p>
Part 2
2.1. STRUCTURAL ANALYSIS
<p>The results of the assessment of the mechanical behaviour (including, as applicable, analysis of thermal stresses, fatigue, brittle fracture and creep) for routine, normal and accident conditions of transport should include the following:</p> <ul style="list-style-type: none">(a) The components of the containment system. This may include special form radioactive material, if applicable, as established in para. 642 of the Transport Regulations;(b) The package components that provide radiation shielding;(c) Any other package components (e.g. shock absorbing components, packaging components that provide heat dissipation) whose performance may have a consequential effect upon (a) and/or (b);(d) The lifting attachments (see paras 608 and 609 of the Transport Regulations);(e) The packaging attachments used for restraining to restrain the package to within its conveyance for routine conditions of transport. <p>If the package is to be transported by air (see paras 619 to 621 of the Transport Regulations), the structural analysis of the containment system should take into account ambient temperatures and pressures that are likely to be encountered in routine conditions of transport as well as the specific temperature and pressure requirements for air transport. Further recommendations are provided in paras 621.2 and 621.3 of SSG-26 (Rev. 1) [2].</p> <p>Attention should be paid to ensure ensuring that any nuts, bolts and other retention devices keep maintain their safety functions during routine conditions of transport, even after repeated use. Further recommendations are provided in para. 613.1 of SSG-26 (Rev. 1) [2].</p> <p>When performing the structural analysis <u>for Type B(U), Type B(M) and Type C packages</u>, the following points should be taken into account <u>considered</u>:</p> <ul style="list-style-type: none">(1) General remarks <u>considerations</u>:<ul style="list-style-type: none">(i) The mechanical properties of the materials considered in the safety demonstration should be representative of the range of mechanical properties of the package components, considering. <u>The analysis should also consider the temperature ranges between range of -40°C (or another specified temperature for Type B(M) packages) and in accordance with para. 667 of the Transport Regulations) to +70°C (see para. 639 of the Transport Regulations) and the temperature range of the respective package components in normal conditions of transport (see para. 653 of the Transport Regulations).</u>(ii) The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material (e.g. wood, polymers, plaster, concrete) should be analysed for the temperature range from of -40°C (or another specified temperature for Type B(M) packages as agreed by in accordance with para. 667 of the competent authority <u>Transport Regulations</u>) to

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>the maximum temperature in normal conditions of transport, and for the range of moisture conditions that is likely to be encountered during transport;</p> <p>(iii) The safety against brittle fracture should be analysed at -40°C (or another specified temperature for Type B(M) packages <u>in accordance with para. 667 of the Transport Regulations</u>) for those components of the containment system made of potentially brittle materials (e.g. ferritic steels, cast iron);</p> <p>(iv) The strength of the lid bolts should be verified for all drop orientations;</p> <p>(v) Any excursion of stress into the plastic domain should be avoided to the extent possible for containment system components, such as bolts and gasket seats that, which would need additional complex proofs concerning the mechanics of the rupture or the maintenance of sufficient gasket seating;</p> <p>(vi) Any possible damage of metallic seals after drops due to vibrations or sliding of the lid should be evaluated;</p> <p>(vii) The internal components (e.g. content, basket, cage) should be verified<u>assessed</u> to <u>ensure that verify that</u> they are not liable to damage the containment system. For the evaluation of the impact of internal components to on the packaging lid, the maximum possible gap between these components and the lid before the drop should be considered;</p> <p>(viii) The condition of the containment system should be determined<u>assessed</u> to demonstrate compliance with the specifications in item 2.3. of the PDSR for the temperature range concerned, i.e. that is, from -40°C (or another specified temperature for Type B(M) packages <u>as agreed by, in accordance with para. 667 of the competent authority</u>) <u>Transport Regulations</u>) to the maximum temperature in accident conditions of transport;</p> <p>(ix) Retention of sufficient thermal protection <u>should be demonstrated</u>, after the mechanical tests for accident conditions of transport, to guarantee the containment or other components<u>components'</u> safety function during the thermal test should be demonstrated.</p> <p>(x) The effect of the thermal test on the mechanical behaviour of the package should be considered (e.g. thermal stresses and strains, thermo-mechanical interactions between package components and, interactions of the package components with the contents); <u>should be considered</u>.</p> <p>(xi) If the shielding includes components made from lead, the consolidation height of lead (lead slump) after the 9 m drop test should be determined, taking into account <u>the</u> environmental conditions described in paras 656 and 657 of the Transport Regulations;</p> <p>(xii) Phenomena such as radiolysis, internal pressure elevation, internal inflammation or explosion, physical changes, <u>and</u> chemical reactions, and accident conditions of transport (including the thermal test) should be considered when analysing the maximum pressure;</p> <p>(xiii) An appropriate water immersion test, depending on the content activity of the package, should be considered.</p> <p>(2) Considerations for experimental mechanical testing:</p> <p>(i) The package orientations should be determined in accordance with paras 722.4, 722.6 and 727.5 of SSG-26 (Rev. 1) [2]. The orientations should be chosen to maximize the loading of the package (in terms of stress, strain, acceleration and deformation);, with consideration of the different package components (e.g. cask body, lid system, shock absorber) and of the protection objectives (e.g. containment and, shielding);.</p> <p>For package orientations, the following tests should be considered:</p> <p>— Tests that maximize the stresses and acceleration (e.g. flat, slap down); the. <u>The</u> greater the impact area, the harder the impact, under the assumption of constant stiffness per unit area;</p>

TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<ul style="list-style-type: none"> — Tests that maximize the deformation (e.g. on cornercorners, on edges): the. <u>The</u> smaller the impact area, the greater the crushing_; — Tests that maximize the damage to orifices, notably by a puncture bar. The containment components in the orifices are often thin and more liable to be damaged by the bar than the body of the packaging_; <u>to be damaged by the bar</u>. — Tests that maximize the risk of perforation by a puncture bar, possibly oblique: if. <u>If</u> the impacted package surface is oblique with respect to the puncture bar, the initial impact takes place on an edge of the puncture bar and the risk of perforation is much higher. (ii) For reduced scale models, geometry and material properties similar to the original design, or conservative geometry and material properties, should be used_; (iii) The results of the drop test with reduced scale models should be assessed to guarantee that they cover, or are transferable to, the original design_; (iv) Drop tests performed with reduced scale models should be demonstrated as representative for the following parameters and components: <ul style="list-style-type: none"> — Drop heights: It might be necessary to increase the drop heights during testing to simulate the total potential energy that would have been received by the package at full scale. This should be considered for drop tests where the characteristic deformation of the structure is not negligible in comparison to the drop height_; — Appropriate geometry scaling of all components (e.g. lids, nuts and bolts, grooves for the seals)_; — Metallic gaskets: <u>The</u> same design, same material and homothetic transformation with regard to elastic restitution should be selected_; — O-rings: the<u>The</u> selection should be based on the similarity of the useful elastic restitution, taking into account the compression set. The change of material properties with the temperature conditions should be considered_; — The scaling of tightening torques for bolts of the reduced scale model should take into account the dispersion of friction conditions, <u>the</u> precision of torques and <u>the</u> technical limitations in an exact geometrical and physical scaling of the containment system components_; — Welding seams should be similar in the scale model and package design_; — For reduced scale model drop testing with significant deformations of shock absorbers, the original package performance should be carefully justified. (v) The experimental mechanical tests should be conducted and reported in accordance with the management system. The test report should address the verification of the package before testing, the description of the test site, the equipment used for measurements and its calibration data, and the results of the measurements performed. This report should also contain pictures showing and explaining the conditions during performance of<u>under which</u> the tests were performed and their results. (3) Considerations for calculations: <ul style="list-style-type: none"> (i) See point (2)(i) above_; (ii) Validated computer codes should be used. Input parameters (e.g. material laws, characteristic values, boundary conditions) should describe sufficiently and precisely the real technical and/or physical problems, and the use of these parameters should be justified_; (iii) If uncertainties exist regarding important input parameters (e.g. material laws), conservative design calculations <u>—</u> including the possible range of material properties <u>—</u> should be performed_;
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TABLE 4. ~~PDSR PACKAGE DESIGN SAFETY REPORT~~ FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(iv) Data used (e.g. material laws, boundary conditions, load assumptions) and calculation results should be documented comprehensively.</p>
<p>2.2. THERMAL ANALYSIS</p> <p>The temperature of the accessible surfaces of a package under the conditions defined in paraspara. 654 or 655 of the Transport Regulations should be determined.</p> <p>The temperature of the package components should be assessed in normal conditions of transport (see para. 653 of the Transport Regulations) and accident conditions of transport (see para. 659-(b) of the Transport Regulations). The thermal analysis should include the thermal behaviour of the following components:</p> <p>(a) The components of the containment system; (b) The components of radiation shielding; (c) The package components whose performance will have a consequential effect uponon (a) andor (b).</p> <p>The following remarks should be taken into account considered:</p> <p>(1) The effects of insolation over a period of 12 hours in accordance with para. 657 of the Transport Regulations; (2) (2) The presence of protective systems liable to oppose heat dissipation in normal conditions of transport. Protective systems to be considered include, as applicable, tarpaulins, canopies, additional screens and outer packaging (e.g. containers, boxes); (3) (3) The solar insolation before and after the thermal test, as defined in para. 728 of the Transport Regulations; (4) (4) The justification for simplifying the assumptions (e.g. absence of trunnions) used for calculation under normal and accident conditions of transport; (5) (5) The analysis of the package in accident conditions of transport under the position (i.e. horizontal or vertical) less least resistant to thermal tests; (3) (6) The value of the surface absorptivity coefficient of the package. The surface absorptivity coefficient should not be lower than 0.8 (see para. 728-(a) of the Transport Regulations) during and after the thermal test to account for deposits uponon the package surface. The surface absorptivity coefficient should also not be lower than the possible maximum value of the emissivity coefficient in routine conditions of transport; (4) (7) The evaluation of the minimum and maximum temperatures of the various components of the packaging, taking account of all the possible positions for the radioactive contents; (5) (8) The profile of heat power based on the burnup distribution in irradiated fuels; (6) (9) The justification that the temperature measurements were performed at thermal equilibrium, when thermal analysis for the conditions specified in paras 654 and 655 of the Transport Regulations is based on test results; (7) (10) The justification that the concentration of oxygen present in the furnace is controlled and in conformity with that obtained in a hydrocarbon fuel–air fire, when the thermal test is madeconducted in a furnace and when it is noted that some package components burn. In addition, control of heat input should be considered thoroughly; (8) (11) The influence of combustible materials that generate additional heat input and affect the fire duration beyond the thermal test; (9) (12) The safety margins on temperature results derived using numerical modelling commensurate with the uncertainty associated to with the numerical model.</p>

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(10)(13) Demonstration that the spare volume in the gasket grooves allows for gasket thermal expansion in the conditions specified in para. 653 of the Transport Regulations and accident conditions of transport, unless appropriate justification is provided.</p>
<h3>2.3. CONTAINMENT DESIGN ANALYSIS</h3>
<p>All possible releases, in the form of gases, liquids, solids or aerosols, through leaks or by permeation, should be included in the containment design analysis.</p> <p>The technical assessment of the containment design should demonstrate compliance with the release criteria for normal and accident conditions of transport, and the following points should be considered:</p> <ul style="list-style-type: none">(a) The mechanical resistance of the irradiated fuel assemblies with respect to the internal pressure should have been assessed in item 2.1 of the PDSR. The risk of rupture due to creep of the rods under the effect of the internal pressure should be evaluated, taking into account the mechanical properties of the fuel cladding for the temperature conditions in normal conditions of transport and for the burnup of the irradiated fuel assemblies in combination with the free drop test.(b) The analysis of the state of the irradiated fuel assemblies in accident conditions of transport (risk of cracking or rupture of the fuel rod at their ends) should have been included in item 2.1 of the PDSR for safety demonstration, if necessary.(c) The <u>fraction of fission gas release</u> fraction out of released from the fuel material should be justified.(d) The presence of debris and of aerosols in the package cavity for irradiated fuels in the case of rupture due to the shearing of the rods should be considered.(e) The formation of aerosols for contents consisting of materials in powder form should be considered for accident conditions of transport.(f) The long-term behaviour of gasket material should be considered (see item 1.4. of the PDSR).(g) A reduction of ambient pressure to 60 kPa should be considered for evaluation of activity release.
<h3>2.4. DOSE RATE ANALYSIS</h3>
<p>ForWhen performing the dose rate analysis, the following points should be considered:</p> <ul style="list-style-type: none">(a) The dose rates for routine and accident conditions of transport and a dose rate increase factor for normal conditions of transport should be assessed to demonstrate compliance with the requirements of the Transport Regulations.(b) The dose rate analysis should be based on assuming the maximum radioactive content of the package or such a content that for a Type B(U), Type B(M) or Type C package as would create the maximum dose rate at the surface of the package and at specific distances from the surface of the package, as defined in the Transport Regulations.(c) The dose rate analysis should take into account the most recent ICRP<u>International Commission on Radiological Protection</u> recommendations on nuclear decay data for dosimetric calculations (see, e.g. see, Ref [9. [7]).(d) The maximum dose rate and a dose rate increase factor for normal conditions of transport, if applicable in accordance with para. paras 523.6 and 624.4 and 523.6 of SSG-26 (Rev. 1) [2], should be determined, taking into account potential amplifying phenomena, such as internal movement of the contents, or, — in the case of packages containing liquids, — change in the state of the contents, including segregation and precipitation of the radionuclides. <p>The following remarks should be taken into account when analysing the points listed above:</p>

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TABLE 4. PDSR PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

<p>(e)(1) Dose rate analysis should be based on the maximum radioactive contents of the package design, which should be defined by various methods and parameters, such as nuclide specific activities, <u>and source terms for gamma and neutron emitters and others as appropriate</u>.</p> <p>(4)(2) The dose rate limits can be shown to be met by calculations or measurements. If calculation methods are used, the calculations of source terms should take into account the interactions, secondary emissions and neutron multiplication factors, when relevant. If <u>dose rate</u> measurements are used, the <u>radiation sources used for the measurements</u> should be <u>selected to be</u> representative of the radioactive contents specified in the package design, and appropriate dose rate measuring techniques should be used for gamma and neutron radiation, as applicable.</p> <p>(2)(3) Dose rate analysis should be performed in such a way that the <u>areas of the package surface areas</u> with the maximum dose rates are identified and analysed. These <u>package surface</u> areas include trunnion areas, areas containing gaps that allow the radiation to pass without being attenuated, and other areas with the potential <u>of</u> increased dose rates due to the package design.</p> <p>(3)(4) All <u>calculational calculation</u> methods used for dose rate analysis should be verified and validated for the specific conditions of the package design <u>that</u> they are applied to.</p> <p>(4)(5) The expected areas for peak dose rates should be specified and checked before shipment.</p> <p>(2)(6) Proof that the sources <u>are maintained will remain</u> secure for drop test sequence conditions in their storage positions (e.g., in irradiators) should be provided in the structural analysis, if applicable.</p> <p>(3)(7) For the materials providing radiation shielding, local melting or combustion during the thermal test should be considered, as determined by the thermal analysis, and the thermal analysis should take into account the effects of penetration or deformation of components by the bar in the mechanical test.</p>
2.5. CRITICALITY SAFETY ANALYSIS
See Appendix V.
2.6. OTHER ANALYSES
<p>Radiolysis and thermolysis phenomena can affect and can be affected by the structural analysis, the thermal analysis, the containment design analysis and the dose rate analysis.</p> <p>If the package contains wet contents, the internal pressure built up inside the package should be assessed and considered for regulatory transport conditions.</p> <p>For the assessment of effects (e.g. internal pressure elevation, internal ignition or explosion) concerning radiolysis and/or thermolysis on the performance characteristics of the package design, the following points should be considered:</p> <ul style="list-style-type: none">(a) If water or hydrocarbonated materials (e.g. cellulose, polymers, aqueous or organic solutions, absorbed humidity) are present in the package, the absence of the risk of accumulation of combustible gases exceeding the limiting concentration for flammability should be demonstrated.(b) When the radiolysis phenomenon limits the maximum safe duration of transport, any specified limit for the duration of transport should integrate margins for incidents and emergency response operations.(c) If leaking fuel rods are allowed as contents and absence of water has not been demonstrated, contained water should be taken into account.

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TABLE 4. ~~PDSR~~PACKAGE DESIGN SAFETY REPORT FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

If applicable, the risk of chemical or physical reactions for materials that react with water or oxygen (e.g. sodium, ~~UF₆~~uranium hexafluoride, plutonium ~~and~~, metallic uranium) should be assessed. Moreover, ~~the~~ potential change of phase (i.e. freezing, melting, boiling), precipitation or segregation should be considered.

DRAFT

~~APPENDIX V – ADDITIONAL INFORMATION FOR PACKAGES CONTAINING FISSILE NUCLIDES~~

**APPENDIX V:
ADDITIONAL INFORMATION
FOR PACKAGES CONTAINING FISSILE NUCLIDES**

V.1. This appendix provides specific additional recommendations on the information to be provided in Parts 1 and 2 of the PDSR for packages containing fissile nuclides, as defined in para. 222 of the Transport Regulations. Table 5 lists each item of the PDSR, with applicable information and guidance.

V.2. The recommendations provided in this appendix apply in addition to those items ~~belonging to~~ ~~associated with~~ the package type defined by the radioactive properties of the contents (see Appendices I ~~to~~ IV).

V.3. Further recommendations are ~~also~~ provided in SSG-26 (Rev. 1) [2], and further guidance can be found in IAEA-TECDOC-1768 [8Ref. [9].

V.4. For packages containing 0.1 kg or more of uranium hexafluoride, see ~~in addition also~~

May be transported in packages whose designs are not approved by the CA for fissile material (or in certain circumstances may be transported unpackaged)			Shall be transported in a CA approved fissile package design	
Non-fissile or fissile-excepted UN number			Fissile UN number	
222	417(a)–(e)	417(f)	674 & 675	Others
Defines the fissile nuclides, and defines fissile material as material containing those nuclides Excludes certain materials from being defined as fissile	Defines limits on the mass, form and isotopic composition of fissile nuclides that except the package or material from further criticality safety consideration	Material specification required to ensure subcriticality set out in a CA “FE” certificate (802(a)(iii))	Define limits on the mass and isotopic composition of fissile nuclides in a package and requirements for the package design that allow transport as a fissile package	Package design specified in a CA fissile “F” certificate (802(a)(v)) (including special arrangements)
Group 1: Not defined as fissile material	Group 2: Exception from UN FISSILE classification and control of accumulation of fissile material by means of control of CSI	Group 3: CSI control with exception from CA approval of package design	Group 4: CSI control with CA approval of package design	

Appendix VI.

APPENDIX V—ADDITIONAL INFORMATION FOR PACKAGES CONTAINING FISSILE NUCLIDES

FIG. 2. Overview of the provisions for the transport of fissile material (adapted from Ref. [8], where CA: Competent Authority, and CSI: Criticality Safety Index). [9], where CA — competent authority; CSI — criticality safety index; FE — fissile-excepted; F — fissile). Paragraph numbers are from the Transport Regulations [1].

The Transport Regulations ~~comprise~~**include** the following four groups of provisions for the transport of radioactive material containing fissile nuclides, also shown in the bottom row of ~~Figure~~**Fig. 2**:

- Group ~~No~~ 1: Transport where the material is not classified as fissile, in accordance with the definition of fissile material;
- Group ~~No~~ 2: Transport with exception from UN “FISSILE” dangerous goods classification and criticality safety index (CSI) ~~accumulation~~ control;
- Group ~~No~~ 3: Transport with UN “FISSILE” dangerous goods classification and **criticality safety index** (CSI) ~~accumulation~~ control, but ~~without~~**excepted from** competent authority approval as a package design for fissile material;
- Group ~~No~~ 4: Transport in a package for which the design is approved by the competent authority to contain fissile material.

V.5. The same package design may be assigned to different groups for different consignments. This should be reflected in the PDSR. For each group, the complete information should be given in the PDSR, as specified in Table 5.

V.6. For Group ~~No~~ 1, no additional information is needed in the PDSR.

V.7. For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.6. ~~“Compliance with regulatory requirements”~~ of the PDSR or, if necessary, in Part 2 of the PDSR.

V.8. For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely identified by precisely indicating a drawing of the packaging (see item 1.3. of the PDSR), including its revision number, and the specification of **the** contents (see item 1.2. of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry or performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the ~~package~~ designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design ~~specifications~~**specifications** provided in items 1.2. and 1.3. of the PDSR or to other assumptions derived from the design specifications and used in the technical analyses. All mechanical and thermal characteristics of each component of the package and **the** acceptance criteria used in technical analyses should be defined. The design assumptions should take into account ageing mechanisms, as necessary. ~~Additional~~**Further** recommendations are provided in paras 613A.1 ~~to~~ ~~613A.4~~ of SSG-26 (Rev. 1) [2].
- (c) The ~~safety~~ demonstration **of compliance** of a package design for fissile material is required to be accomplished in accordance with para. 701 of the Transport Regulations by any of the following methods or by a combination thereof:
 - (i) ~~The~~ results of physical testing of prototypes or models of appropriate scale;

~~APPENDIX V – ADDITIONAL INFORMATION FOR PACKAGES CONTAINING FISSILE NUCLIDES~~

- (i) . When a programme for physical testing of prototypes or models of appropriate scale is implemented for a specific package design to be approved by the competent authority, the competent authority should be notified of the programme ~~in advance of before~~ the testing and ~~the competent authority~~ should be allowed to witness the testing. When such a programme of tests is done without competent authority approval, but is part of the safety analysis, its validity is to be determined by the competent authority.
- (ii) Reference to previous satisfactory demonstrations of a sufficiently similar nature. Test results of designs similar to the design under consideration are permissible if the similarity can be demonstrated sufficiently by justification and validation.
- (iii) Calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions should be clearly stated and fully justified, including by physical testing if applicable.

~~Additional~~Further recommendations are provided in paras 701.1–701.25 of SSG-26 (Rev. 1) [2].

The methods or standards used in each analysis specified in items 2.1 ~~to~~ 2.4 of the PDSR should include a description of the analysis technique used, the limitations and accuracy of this technique and ~~the~~ demonstration of the correct application of the technique for the analysis of the package design.

If computer codes are used for the safety analysis, ~~then~~ additional information should be included in the PDSR to justify/demonstrate that the code is verified and validated ~~in its~~ for the specific field of use. The justification for the applicability of these codes should include a statement of possible sources of ~~errors/error~~ and/or ~~uncertainties/uncertainty~~ relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications, as well as of any other parameter influencing the calculated results. ~~This may include and a~~ sensitivity analysis.

- (d) The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions, to be fulfilled by different components of the package design, comply with the regulatory requirements. Other hazards ~~that may have a consequential effect on the safety functions of the package should be analysed. This may concern~~ (e.g. corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes) should be analysed, as necessary, if they have a consequential effect on the safety functions of the package.
- (e) The results of the technical analyses should be compared with the acceptance criteria, and package design assumptions and regulatory compliance should be justified accordingly.

V.9. The following items listed in ~~Figure~~Fig. 1 and para. 2.43 of this Safety Guide, are not relevant to and not needed for packages containing fissile nuclides: ~~and, therefore, are not included in Table 5:~~

— Part 2:

- Dose ~~Rate Analysis~~rate analysis;
- Other analyses.

~~APPENDIX V – ADDITIONAL INFORMATION FOR PACKAGES CONTAINING FISSILE NUCLIDES~~

TABLE 5. ~~PDSR~~PACKAGE DESIGN SAFETY REPORT FOR PACKAGES CONTAINING FISSILE NUCLIDES, ADDITIONAL INFORMATION

Part 1
1.1. ADMINISTRATIVE INFORMATION
<p>Group No-2:</p> <p>When one of the provisions of subparagraphs (a) to (f) of para. 417(a)–(f) of the Transport Regulations applies to the package, then a reference to the provision should be added. Especially, when para. 417 (f) applies, multilateral approval is required for the exception of the contents.</p> <p>Group No-3:</p> <p>When one of the provisions of subparagraphs (a) to (e) of para. 674(a)–(c) or of paragraphpara. 675 applies to the package contents, then a reference to this provision should be added. The colloquial name of the package, if applicable, should be added.</p> <p>Group No-4:</p> <p>The following administrative information should be added, when necessary:</p> <p>a) Type <u>type</u> of package.</p>
1.2. SPECIFICATION OF THE CONTENTS
<p>The description of the contents and of their physical and chemical forms and radionuclides should be sufficiently precise to allow the demonstration of compliance with the requirements for prevention of criticality.</p> <p>The following information should be added, as necessary:</p> <p>(a) Group No-2: Mass<u>The mass</u> of fissile nuclides and enrichment, if applicable.</p> <p>(b) Group No-3:</p> <p>(a)(i) <u>Mass</u>The mass of fissile nuclides and enrichment, if applicable;</p> <p>(b)(ii) <u>Other limitations</u> to<u>on</u> the contents, as described in para. 674-(d) or 675-(c) of the Transport Regulations;</p> <p>(e)(iii) <u>The formula</u> for calculating the criticality safety index (CSI) in accordance with para. 674 or 675 of the Transport Regulations.</p> <p>(c) Group No-4:</p> <p>(a)(i) <u>Mass</u>The mass of fissile nuclides and enrichment of the contents, if applicable. A description of quantities of nuclides not defined as fissile, but able to sustain chain reaction (e.g. if certain actinides could be present in sufficient quantity or concentration to increase the neutron multiplication factor, their concentrations and/or quantities should be defined).</p> <p>(b)(ii) <u>The criticality safety index (CSI)</u> and the value of the number N defined in paras 684 and 685 of the Transport Regulations.</p> <p>(e)(iii) <u>Safety relevant limits</u> for non-radioactive materials (e.g. moderators, reflectors), for example limits in<u>on</u> material composition, density, form, <u>or</u> location within package, <u>or</u> restrictions of relative quantities of materials.</p> <p>Criticality safety can be very sensitive to the presence and geometrical arrangement of fissile material (e.g. possibility and size of lattice arrangements), moderators (e.g. water, graphite, beryllium, and other</p>

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<p>light elements) and reflectors. This should be taken into account in the description of the permitted and not permitted contents.</p>
<h3>1.3. SPECIFICATION OF THE PACKAGING</h3>
<p>No additional information is needed for Group No-2.</p> <p>The following information should be added, when necessary:</p> <p>Group No-3:</p> <p>(a) Testing specifications and controls before first use to transport radioactive material. This ensures compliance of the fabrication to<u>with</u> the design and allows acceptance of the specimen before its first use. See also para. 501 of the Transport Regulations.</p> <p>Group No-4:</p> <p>(a) The overall dimensions, the maximum mass of the package; when fully loaded, and the mass of the empty package<u>packaging</u> (additional configurations may be included, depending on the operation<u>operating</u> conditions);.</p> <p>(b) A list of packaging components important to safety and their materials, including the specifications and methods of manufacture <u>of the components</u>, specifications for material procurement, welding, other special processes, <u>and</u> non-destructive examination and testing. The properties of materials of components that are expected to maintain their safety function under the thermal test; should be given for a range of temperature reachable during such a test;.</p> <p>(c) A description of the package<u>packaging</u> components of the confinement system (such as<u>e.g.</u> neutron poisons, moderators, flux traps and, spacer);).</p> <p>(d) A description of the packaging components for heat dissipation;.</p> <p>(e) A description of the packaging components for thermal protection;.</p> <p>(f) Testing specifications and controls before first use to transport radioactive material. This ensures compliance of the fabrication to<u>with</u> the design and allows acceptance of the specimen before its first use. See also para. 501 of the Transport Regulations.</p>
<h3>1.4. AGEING CONSIDERATIONS</h3>
<p>Depending on the package design, the information relating to the ageing considerations, expected in this section of the PDSR, can also be provided by the package designer directly in the table mentioned in item 1.6 "Compliance with regulatory requirements".</p> <p>For packagings<u>packaging</u> used once for a single transport and not intended for shipment after storage, this section<u>item</u> of the PDSR should be left blank.</p> <p>For all other packagings<u>packaging</u>, this section<u>item</u> of the PDSR should include the following information:</p> <p>(a) The intended conditions of use of the package that might influence ageing;</p> <p>(b) The potential ageing mechanisms that are relevant for<u>to</u> the package design, taking into account the intended conditions of use of the package;</p> <p>(c) Operational measures (including maintenance and inspection activities before shipment) to monitor and limit the ageing effects;</p>

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<p>(d) Analysis of the influence of the ageing of <u>the</u> packaging and contents on the design assumptions for demonstration of compliance with the regulations, including the technical analyses in Part 2 of the PDSR, considering the specified intended use conditions, ageing mechanisms and operational measures.</p> <p>More<u>Further</u> recommendations are provided in paras 613A.1 to <u>—</u>613A.5 of SSG-26 (Rev. 1) [2].</p>
<h3>1.5. CONDITIONS FOR TECHNICAL ANALYSES</h3>
<p>No additional information is needed for Groups No-2 and No-3.</p> <p>Group No-4: This <u>section item of the PDSR</u> should describe the main design principles and performance characteristics of the package design to meet the criticality safety requirements of the Transport Regulations.</p> <p>This <u>section item</u> should summarize the analyses performed in Part 2 of the PDSR and describe how analysis assumptions and data used for the criticality safety analysis are derived from the design and the behaviour of the package for routine, normal and accident conditions of transport, also taking into account ageing mechanisms (see item 1.4. of the PDSR).</p> <p>This <u>section item</u> will help to ensure that the package design and the various parts of the safety demonstration are compatible with one another.</p> <p>All assumptions about the state of the package used in the criticality safety assessment for normal and accident conditions of transport should be listed and well justified. The state of the components of the confinement system under normal and accident conditions should be derived from the design and the behaviour of the package under the test conditions. Otherwise, conservative assumptions should be taken, and their conservatism should be demonstrated.</p> <p>Often, test conditions leading to the maximum damage in terms of activity release or dose rate increase do not result in the maximum neutron multiplication. Therefore, for the criticality safety assessment, additional tests may have to be considered. For any parameter not justified, the value leading to maximum neutron multiplication should be identified and used in the criticality safety assessment. For cases where complete or partial water filling of cavities is important for criticality safety, the filling states considered and those excluded from the assessment should be described and justified.</p>
<h3>1.6. COMPLIANCE WITH REGULATORY REQUIREMENTS</h3>
<p>The PDSR should include a complete list of all paragraphs of the Transport Regulations and other international or national regulations applicable to packages containing fissile nuclides.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be demonstrated using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for packages containing fissile nuclides are provided in a matrix in Annex I.</p>
<h3>1.7. PACKAGE OPERATIONS</h3>
<p>The following information should be added, when necessary:</p>

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<p>Group No-2:</p> <p>— Any operational controls to be applied during transport, including consignment and conveyance limits.</p> <p>Group No-3:</p> <p>— Specifications for assembling of the packaging components, including compliance with the requirements established in para. 637 of the Transport Regulations.</p> <p>Group No-4:</p> <p>— (a) Testing specifications and controls before each shipment:</p> <ul style="list-style-type: none">(i) The methods used for operational controls and tests. In, in particular, those required in accordance with paras 502 and 503 of the Transport Regulations, should be detailed;(ii) For drying operations, the method used should prevent formation of ice;(iii) For leak-tightnessleaktightness testing, qualified methods should be implemented (see item 2.3- of the PDSR). For packages that are or have been in contact with water, it should be demonstrated that the presence of water does not impair the validity of the leak tightnessleaktightness testing by sealing the leakage paths;(iv) The check for the presence of absorber rods or for the selection of inner equipment with the correct neutron absorber content should be specified, if applicable;(v) The control of tightening torques of the bolts and of the correct position of the lid should be specified; <p>— Specifications for the assembling of the packaging components, including compliance with the requirements established in para. 637 of the Transport Regulations.</p> <p>If written procedures with a detailed description of these activities are available, then reference should be made to these procedures.</p>
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1.8. MAINTENANCE

No additional information is needed for Groups ~~No~~-2 and ~~No~~-3.

Group ~~No~~ 4: The following information should be added, if necessary:

- ~~(a)~~ Periodic maintenance and inspection activities should be detailed and may include the following activities and tests, depending on the package design:
 - ~~(a)(i)~~ Visual inspections and measurements, ~~(including tie-down and handling attachments);~~
 - ~~(b)(ii)~~ The control of all void spaces of the package (*i.e.* cavity and other spaces), in particular regarding water penetration;
 - ~~(c)(iii)~~ Weld examinations;
 - ~~(d)(iv)~~ Structural (including internal enclosures, and tie-down and handling attachments) and pressure tests;
 - ~~(e)(v)~~ Component and material tests, ~~including tests for~~ (screws, bolts, welds, neutron absorbers, basket-, etc.).
- ~~(b)~~ The ~~definition of the~~specified periodicity of replacement of the packaging components should take into account any reduction in efficiency due to wear, corrosion and/or ageing.
- ~~(c)~~ The justification of the periodicity of activities, when needed, should also be included in this ~~section~~item of the PDSR.

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1.9. GAP ANALYSIS PROGRAMME
<p>No additional information is needed for Groups No.2 and No.3.</p> <p>Group No.4: Additional information about the systematic procedure for a periodic evaluation of changes in technical knowledge should be provided, if necessary.</p>
1.10. MANAGEMENT SYSTEM
<p>No additional information is needed for Groups No.2 and No.3.</p> <p>Group No.4: The management system should cover the following activities, if necessary:</p> <p>(a) Package design, PDSR, documentation, <u>and</u> records;</p> <p>(b) Manufacture and testing of the packagepackaging;</p> <p>(c) Operation (<u>i.e. preparation</u>, loading, transportcarriage, storage in transit, receipt, and shipment after storage, unloading <u>and receipt</u>);</p> <p>(d) Maintenance, repair and inspection of the packagepackaging.</p> <p>The management system should include the descriptiondescriptions of the actions to be performed to check the compliance with the PDSR of the documents relating to package operation (e.g. manufacturemanufacturing, operation or maintenance manual manuals) <u>with the PDSR and should also cover</u> the management of deviations detected in the framework of any transport activity.</p> <p>For all components important to safety, the PDSR should define the parameters to be guaranteed to assureensure compliance with the package design, and therebytherefore safety, and the level of controls <u>required</u> during manufacturing and maintenance.</p>
1.11. PACKAGE ILLUSTRATION
<p>No additional information is needed for Group No.2.</p> <p>Group No.3: A reproducible illustration should be provided showing the make-up of the package, including shock absorbers and internal arrangements, if applicable.</p> <p>The illustration should indicate at least the overall outside dimensions and the mass of the package when empty and when loaded.</p> <p>Group No.4: A reproducible illustration should be provided showing the make-up of the package, including shock absorbers, devices for thermal protection, and internal arrangements, if applicable.</p> <p>The illustration should indicate at least the overall outside dimensions and the mass of the package when empty and when loaded.</p>
Part 2
2.1. STRUCTURAL ANALYSIS
<p>There is no need for an additional structural analysis for Groups No.1 and No.Group 2.</p> <p>An additional structural analysis should be performed under the following conditions:</p>

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- For Group 3, an additional structural analysis for industrial packages should be included if the demonstration of compliance with the requirements established in para. 674-(b) or (c) of the Transport Regulations relies on the performance of the package under normal conditions of transport and is not otherwise assessed for the package design.
- For Group 4, an additional structural analysis should be included if the criticality safety assessment relies on the performance of the package under normal or accident conditions of transport and is not otherwise assessed for the package design.

The ~~results of the~~ additional assessment of the mechanical behaviour (including, as applicable, analysis of thermal stresses, fatigue, brittle fracture and creep) for routine, normal and accident conditions of transport should ~~cover~~ include the following:

- (a) The components of the confinement system;
- (b) Any other package components (e.g. shock absorbing components, packaging components that provide heat dissipation) whose performance may have a consequential effect ~~upon~~ (a);
- (c) The mechanical stability of the fissile material and any structure that is used to maintain its geometry, if necessary, for the criticality safety assessment. Other important criticality safety relevant items that should be considered are water leaking into or out of the package (totally or partially), the rearrangement of the fissile material and the degradation of neutron traps.

See also the remarks in item ~~1.5~~ of the PDSR.

~~The~~ When performing the structural analysis, the following ~~remarks~~ points should be ~~taken into account~~ considered:

- (1) General ~~remarks~~ considerations:
 - (i) The mechanical properties of the materials considered in the safety demonstration should be representative of the range of mechanical properties of the package components. The analysis should also consider the temperature range of the ~~respective~~ package components for ~~the~~ an ambient temperature range of -40°C to $+38^{\circ}\text{C}$ or another temperature range specified by the competent authority in accordance with para. 679 of the Transport Regulations;
 - (ii) The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material (e.g. wood, polymers, plaster, concrete) should be analysed for an ambient temperature range of -40°C to $+38^{\circ}\text{C}$, or another temperature range specified by the competent authority in accordance with para. 679 of the Transport Regulations, and for the range of moisture ~~that is~~ likely to be encountered during transport;
 - (iii) The safety against brittle fracture ~~of components of the confinement system made of potentially brittle materials (e.g. ferritic steels, cast iron)~~ should be analysed at -40°C or another temperature specified by the competent authority in accordance with para. 679 of the Transport Regulations; for those components of the confinement system made of potentially brittle materials (e.g. ferritic steels, cast iron).
 - (iv) The strength of lid bolts should be ~~justified~~ verified for all drop orientations;
 - (v) Any excursion of stress into the plastic domain should be avoided to the extent possible for confinement system components, such as bolts and gasket seats ~~that, which~~ would ~~require~~ need additional complex proofs concerning the mechanics of the rupture or the maintenance of sufficient gasket seating;
 - (vi) Any possible damage of metallic seals after drops due to vibrations or sliding of the lid should be evaluated;
 - (vii) The internal components (e.g. content, basket, cage) should be ~~verified~~ assessed to ~~ensure~~ verify that they are not liable to damage the confinement system. For the evaluation of

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<p>the impact of internal components to on the packaging lid, the maximum possible gap between these components and the lid before the drop should be considered;.</p> <p>(viii) The condition of the confinement system should be determined to demonstrate compliance with the specification of packaging presented specifications in item 12.3. of the PDSR for an ambient temperature range from of -40°C to +38°C or another temperature range specified by the competent authority in accordance with para. 679 of the Transport Regulations;.</p> <p>(ix) Retention of sufficient thermal protection <u>should be demonstrated</u>, after the mechanical tests for accident conditions of transport, to guarantee the confinement system during the thermal tests should be demonstrated; test.</p> <p>(x) The effect of the thermal test on the mechanical behaviour of the package components should be considered (e.g. thermal stresses and strains, thermo-mechanical interactions between package components, interactions of the package components with contents;) <u>should be considered</u>.</p> <p>(xi) An appropriate water immersion test should be considered.</p> <p>(2) Considerations for experimental mechanical testing:</p> <p>(+) The package orientations should be determined in accordance with paras 722.4, 722.6 and 727.5 of SSG-26 (Rev. 1) [2]. The orientations should be such that maximize the loading of the package (in terms of stress, strain, acceleration and deformation)), with consideration of the different package components (e.g. cask body, lid system, shock absorber) and of the protection objective (<u>i.e.</u> criticality safety).</p> <p><u>(i)</u> For package orientations, the following tests should be considered:</p> <ul style="list-style-type: none">— Tests that maximize the stresses and acceleration (e.g. flat, slap down)); the. The greater the impact area, the harder the impact, under the assumption of constant stiffness per unit area;.— Tests that maximize the deformation (e.g. on corner corners, on edges)); the. The smaller the impact area, the greater the crushing;.— Tests that maximize the damage to orifices, notably by a puncture bar. The containment components in the orifices are often thin and more liable to be damaged by the bar than the body of the packaging; <u>to be damaged by the bar</u>.— Tests that maximize the risk of perforation by a puncture bar, possibly oblique); if. If the impacted package surface is oblique with respect to the puncture bar, the initial impact takes place on an edge of the puncture bar and the risk of perforation is much higher. <p>(ii) For reduced scale models, geometry and material properties similar to the original design, or conservative geometry and material properties, should be used.</p> <p>(iii) The results of the drop test with reduced scale models should be assessed to guarantee that they cover, or are transferable to, the original design.</p> <p>(iv) The representativeness of drop Drop tests performed with reduced scale models should be demonstrated <u>as representative</u> for the following parameters and components:</p> <ul style="list-style-type: none">— Drop heights: #Ht might be necessary to increase the drop heights during testing to simulate the total potential energy that would have been received by the package at full scale. This should be considered for drop tests where the characteristic deformation of the structure is not negligible in comparison to the drop height;.— Appropriate geometry scaling of all components (e.g. lids, nuts and bolts, grooves for the seals);).
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<ul style="list-style-type: none">— Metallic gaskets: The same design, same material and homothetic transformation with regard to elastic restitution should be selected;— O-rings: theThe selection should be based on the similarity of the useful elastic restitution, taking into account the compression set. The change of material properties with the temperature conditions should be considered;— The scaling of tightening torques for bolts of the reduced scale model should take into account the dispersion of friction conditions, the precision of torques and the technical limitations in an exact geometrical and physical scaling of the containment system and of the confinement system components;— Welding seams should be similar in the scale model and package design;— In case ofFor reduced scale model drop testing with significant deformations of shock absorbers, the original package performance should be carefully justified. <p>(v) The experimental mechanical tests should be conducted and reported in accordance with the management system. The test report should address the verification of the package before testing, the description of the test site, the equipment used for measurements and its calibration data, and the results of the measurements performed. This report should also contain pictures showing and explaining the performing conditions ofunder which the tests were performed and their results.</p> <p>(3) Considerations for calculations:</p> <ul style="list-style-type: none">(i) See point (2)-(i) above;(ii) Validated computer codes should be used. Input parameters (e.g. material laws, characteristic values, boundary conditions) should describe sufficiently and precisely the real technical and/or physical problems, and the use of these parameters should be justified;(iii) If uncertainties exist regarding important input parameters (e.g. material laws), conservative design calculations — including the possible range of material properties — should be performed;(iv) Data used (e.g. material laws, boundary conditions, load assumptions) and calculation results should be documented comprehensively.
<h2>2.2. THERMAL ANALYSIS</h2>
<p>The temperature of the package components should be assessed in accident conditions of transport (see para. 659-(b) of the Transport Regulations). The thermal analysis should include the thermal behaviour of the following components:</p> <ul style="list-style-type: none">(a) The components of the confinement system;(b) The package components whose performance will have a consequential effect uponon (a). <p>The following remarks should be taken into accountconsidered:</p> <ul style="list-style-type: none">(1) The effects of insolation onover a period of 12 hours in accordance with para. 657 of the Transport Regulations;(2) Consideration of theThe solar insolation before and after the thermal test, as defined in para. 728 of the Transport Regulations;(3) The justification for simplifying the assumptions (e.g. absence of trunnions) used for calculation under normal and accident conditions of transport;(4) The analysis of the package in accident conditions of transport under the position (i.e. horizontal or vertical) lessleast resistant to thermal tests;

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<p>(5) The value of the surface absorptivity coefficient of the package. The surface absorptivity coefficient should not be lower than 0.8 (see para. 728-(a) of the Transport Regulations) during and after the thermal test to account for deposits upon the package surface. The surface absorptivity coefficient should also not be lower than the possible maximum value of the emissivity coefficient in routine conditions of transport;.</p> <p>(6) The evaluation of the minimum and maximum temperatures of the various components of the packaging, taking account of all the possible positions for the radioactive contents;.</p> <p>(7) The profile of heat power based on the burnup distribution in irradiated fuels</p> <p>(8) The justification that the concentration of oxygen present in the furnace is controlled and in conformity with that obtained in a hydrocarbon fuel–air fire, when the thermal test is conducted in a furnace and when it is noted that some package components burn. In addition, control of heat input should be considered thoroughly;.</p> <p>(9) The influence of combustible materials that generate additional heat input and affect the fire duration beyond the thermal test;.</p> <p>(10) The safety margins on temperature results derived using numerical modelling commensurate with the uncertainty associated towith the numerical model;.</p> <p>(11) Demonstration that the spare volume in the gasket grooves allows for gasket thermal expansion in accident conditions of transport, unless appropriate justification is provided.</p>
<p>2.3. CONTAINMENT DESIGN ANALYSIS</p>
<p>The extent of the additional information to be considered in the containment design analysis depends ofon the assumptions used to demonstrate criticality safety with regardsregard to the fissile material that escapes from the package (see para. 685-(c) of the Transport Regulations) and the quantity of water that leaks into or out of all void spaces of the package (see para. 680 of the Transport Regulations).</p>
<p>2.4. CRITICALITY SAFETY ANALYSIS</p>
<p>For packages designed to transport fissile material not excepted by paras 417, 674 or 675 of the Transport Regulations (i.e. packages in Group No. 4), the assessment of criticality safety for routine, normal and accident conditions of transport, is required to be performed, both for the–isolated packagepackages and for the arrays of packages is required to be performed.</p> <p>The following remarks, if applicable, should be taken into accountconsidered in the criticality safety analysis:</p> <p>(a) Contents:</p> <p>(i) All possible configurations with any possible geometrical and physical characteristics (e.g. dimensional tolerances, positions of the components, density of powders in normal or accident conditions of transport) within the range set by the description of the contents and the packaging (see items 1.3. to–1.6. of the PDSR);.</p> <p>(ii) Materials with a hydrogen concentration highergreater than that of water that may be present in the package;.</p> <p>(iii) Natural or depleted uranium that may be present in the package, with appropriate assumptions relative toabout quantities and localization.</p> <p>(b) Configurations to be analysed:</p> <p>(i) If special features preventing water leakage are considered for the criticality safety analysis for a package in isolation (see para. 680-(a) of the Transport Regulations), the criterion for water</p>

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<p>tightness to be defined by the package designer and accepted by the competent authority should be given and justified in the PDSR. This criterion should be set in such a way <u>as</u> to exclude ingress of an amount of water that could influence the criticality safety assessment. The testing conditions defined in para. 680 of the Transport Regulations should be taken into account³.</p> <p>(ii) For packages to be transported by air, subcriticality of the isolated package should be assessed under conditions consistent with Type C package tests, assuming reflection by at least 20 cm of water but no water <u>inleakagein-leakage</u>. If the behaviour of the package under these conditions is not assessed, typical envelope configurations should be considered, such as the following:</p> <ul style="list-style-type: none">- The fissile material contained in one package (without consideration of water ingress from outside the package) in spherical shape reflected by 20 cm of water³.- The fissile material contained in one package (without consideration of water from outside the package), pure or mixed with all or part of the moderating materials of the package, in spherical shape, surrounded by the reflecting materials (e.g. steel, lead) of the package and reflected by 20 cm of water. <p>(iii) In modelling, all the elements of structures that could increase the neutron multiplication should be taken into account³.</p> <p>(iv) The package designer should check the qualification of criticality calculation tools and should specify the critical experiments used for benchmarking of the calculation <u>tool thattools, which</u> should be representative of the single package in isolation and the applicable arrays of packages. Special attention should be paid to systems (e.g. low-moderation systems, fuel assemblies) for which the qualification base is not really extended and for which it is desirable to use calculation models that are conservative in terms of calculation assumptions and provide margins to compensate for the lack of qualification, when applicable³.</p> <p>(v) When appropriate, the justifications should take into account all the possible ranges of the masses and moderations. Credible conditions of transport that might lead to preferential (heterogeneous) flooding of packages increasing the neutron multiplication should be considered³.</p> <p>(vi) For certain configurations where the interactions can be dominating, the impact of the variations <u>ofin</u> density of the fissile medium should be studied³.</p> <p>(vii) The heterogeneous nature of the fissile material during transport should be considered³.</p> <p>(viii) The assumption of a homogeneous enrichment equal to the average enrichment for uranium dioxide for boiling water reactor (<u>BWR</u>) assemblies should be proven to be conservative, especially if the assembly geometry may change under the test conditions specified in the Transport Regulations³.</p> <p>(ix) For spent fuel initially containing plutonium, a conservative irradiation level that takes into account the possible evolution of reactivity during irradiation should be considered.</p> <p>Further recommendations on criticality safety assessments are given in <u>Appendixappendix VI ofto</u> SSG-26 (Rev.- 1) [2]. Further recommendations on the application of burnup credit in criticality safety assessments of spent nuclear fuel are provided in IAEA Safety Standards Series No. SSG-27³, (<u>Rev. 1</u>), Criticality Safety in the Handling of Fissile Material [10]. Additional information can be found in ISO 27468:<u>2011</u> [11] and in publications from the Expert Group on Burn-up Credit Criticality Safety of the OECD/<u>NEA</u> [12]. <u>Nuclear Energy Agency</u>.³</p>

³ See <https://www.oecd-nea.org/science/wpncs/buc/index.html>.

~~APPENDIX VI – ADDITIONAL INFORMATION FOR PACKAGES CONTAINING
0.1 KG OR MORE OF URANIUM HEXAFLUORIDE~~

**APPENDIX VI.
ADDITIONAL INFORMATION FOR PACKAGES
CONTAINING 0.1 kg OR MORE OF URANIUM HEXAFLUORIDE**

VI.1. This appendix provides specific additional recommendations on the information to be provided in Parts 1 and 2 of the PDSR for packages containing 0.1 kg or more of uranium hexafluoride. Table 6 lists each item of the PDSR, with applicable information and guidance.

VI.2. The recommendations provided in this appendix apply in addition to those ~~items belonging to~~ associated with the package type defined by the radioactive properties of the contents, ~~(see Appendices II to IV).~~

VI.3. Further recommendations are ~~available~~ provided in SSG-26 (Rev. 1) [2].

VI.4. For packages containing fissile nuclides, see in addition Appendix V.

VI.5. For technical analyses, compliance of the package with the Transport Regulations should be demonstrated by the package designer either directly in item 1.6. ~~“Compliance with regulatory requirements”~~ of the PDSR or, if necessary, in Part 2 of the PDSR.

VI.6. For each of the technical analyses in Part 2 of the PDSR, the following considerations apply:

- (a) The package design ~~that is~~ being evaluated should be uniquely ~~and identified by~~ precisely identify ~~by~~ indicating ~~the~~ a drawing of the packaging (see item 1.3. of the PDSR), including its revision number, and the specification of the contents (see item 1.2. of the PDSR), including its revision number.
- (b) The acceptance criteria for the technical analyses and the package design assumptions relating to geometry or performance characteristics should be defined and justified when necessary. The acceptance criteria should be specified by the designer and should be derived from the criteria established by the regulatory body and from other applicable standards developed to meet the regulatory requirements. The design assumptions refer to the design ~~specifications~~ specifications provided in items 1.2. and 1.3. of the PDSR and to other assumptions derived from the design ~~specifications~~ specifications and used in the technical analyses. All mechanical and thermal characteristics of each component of the package and the acceptance criteria used in technical analyses should be defined. The design assumptions should take into account ageing mechanisms, as necessary. ~~Additional~~ Further recommendations are provided in paras 613A.5 and 613A.6 of SSG-26 (Rev. 1) [2].
- (c) The ~~safety demonstration of compliance~~ of a package design containing 0.1 kg or more of uranium hexafluoride is required to be accomplished in accordance with para. 701 of the Transport Regulations by any of the following methods or by a combination thereof:
 - ~~(i)~~ The results of physical testing of prototypes or models of appropriate scale;
 - (i) . When a programme for physical testing of prototypes or models of appropriate scale is implemented for a specific package design to be approved by the competent authority, the competent authority should be notified of the programme ~~in advance of~~ before the testing and should be allowed to witness the testing. When such a programme of tests is done without competent authority approval, but is part of the safety analysis, its validity is to be determined by the competent authority.
 - (ii) Reference to previous satisfactory demonstrations of a sufficiently similar nature. Test results of designs similar to the design under consideration are permissible if the similarity can be demonstrated sufficiently by justification and validation;

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- (iii) Calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions should be clearly stated and fully justified, including by physical testing if applicable.

~~Additional~~Further recommendations are provided in paras 701.1–701.25 of SSG-26 (Rev. 1) [2].

The methods or standards used in each analysis specified in items 2.1–~~to~~–2.3 of the PDSR should include a description of the analysis technique used, the limitations and accuracy of this technique and ~~the~~a demonstration of the correct application of the technique for the analysis of the package design.

If computer codes are used for the safety analysis, ~~then~~additional information should be included in the PDSR to ~~justify~~demonstrate that the code is verified and validated ~~in its~~for the specific field of use. The justification for the applicability of these codes should include a statement of possible sources of ~~error~~error and/or ~~uncertainties~~uncertainty relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications, as well as of any other parameter influencing the calculated results. ~~This may include and a~~ sensitivity analysis.

- (d) The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions to be fulfilled by different components of the package design comply with the regulatory requirements. ~~The performance characteristics of the package design should be assessed. More than one sequence of tests might need to be considered to ensure that the various safety functions, to be fulfilled by different components of the package design, comply with the regulatory requirements.~~ Other hazards ~~that may have a consequential effect on the safety functions of the package should be analysed. This may concern~~(e.g. corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes) should be analysed, as necessary, if they have a consequential effect on the safety functions of the package.
- (e) The results of the technical analyses should be compared with the acceptance criteria, and package design assumptions and regulatory compliance should be justified accordingly.

VI.7. The following items listed in ~~Figure~~Fig. 1 and para. 2.43 of this Safety Guide, are not relevant ~~to~~ and not needed for packages containing 0.1 kg or more of uranium hexafluoride and, therefore, are not included in Table 6:

- Part 2:
 - Dose rate analysis;
 - Criticality safety analysis;
 - Other analyses.

TABLE 6. ~~ADDITIONAL INFORMATION~~PACKAGE DESIGN SAFETY REPORT FOR PACKAGES CONTAINING 0.1 kg OR MORE OF URANIUM HEXAFLUORIDE, ADDITIONAL INFORMATION

4. Part 1
1.1. ADMINISTRATIVE INFORMATION
The colloquial name of the package, if applicable, should be added.

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1.2. SPECIFICATION OF THE CONTENTS
Compliance A detailed description of the permitted contents in accordance with the requirements for packages containing uranium hexafluoride established in para. 420 of the Transport Regulations should be considered provided.
1.3. SPECIFICATION OF THE PACKAGING
The following information should be added, when necessary: <ul style="list-style-type: none">(a) A list of packaging components important to safety and their materials, including the specifications and methods of manufacture of the components, specifications for material procurement, welding, other special processes, <u>and</u> non-destructive examination and testing. The properties of materials of components that are expected to maintain their safety function under the thermal test, should be given for a range of temperature reachable during such a test.(b) A description of the packaging body and closure mechanism;(c) A description of the packaging components for thermal protection;(d) Testing specifications and controls before first use to transport uranium hexafluoride. This ensures compliance of the fabrication towith the design and allows acceptance of the specimen before its first use. See also para. 501 of the Transport Regulations.
1.4. AGEING CONSIDERATIONS
Depending on the package design, the information relating to the ageing considerations, expected in this section of the PDSR, can also be provided by the package designer directly in the table mentioned in item 1.6. “Compliance with regulatory requirements” For packagings packaging used once for a single transport and not intended for shipment after storage, this section item of the PDSR should be left blank. For all other packagings packaging, this section item of the PDSR should include <u>the following information</u> : <ul style="list-style-type: none">(a) The intended conditions of use of the package that might influence ageing;(b) The potential ageing mechanisms that are relevant to the package design, taking into account the intended conditions of use of the package;(c) Operational measures (including maintenance and inspection before shipment) to monitor and limit the ageing effects;(d) Analysis of the influence of the ageing of <u>the</u> packaging and contents on the design assumptions for demonstration of compliance with the regulations, including the technical analyses in Part 2 of the PDSR, considering the specified intended use conditions, ageing mechanisms and operational measures. More Further recommendations are provided in para paras 613A.5 and 613A.6 of SSG-26 (Rev. 1) [2].
1.5. CONDITIONS FOR TECHNICAL ANALYSES

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<p>— The package designer <u>This item of the PDSR</u> should describe the main principles and performance characteristics of the package design to meet the safety requirements (e.g. leakage, stress, rupture) of the Transport Regulations.</p> <p>— This section <u>item</u> should summarize the analyses performed in Part 2 of the PDSR and describe how analysis assumptions and data used for the safety analysis — especially regarding leakage, stress, <u>and</u> rupture — are derived from the design and the behaviour of the package for routine, normal and accident conditions of transport, also taking into account ageing mechanisms (see item 1.4. of the PDSR).</p> <p>— This section <u>item</u> will help to ensure that the package design and the various parts of the safety demonstration are compatible with one another.</p>
1.6. COMPLIANCE WITH REGULATORY REQUIREMENTS
<p>The PDSR should include a complete list of all paragraphs of the Transport Regulations and other international or national regulations applicable to packages containing 0.1 kg or more of uranium hexafluoride.</p> <p>Compliance of the package design with these regulations should be demonstrated in the PDSR. This could be done <u>demonstrated</u> using a table (or any other written format) linking the appropriate items of the PDSR, where compliance is demonstrated, to the applicable paragraphs of the regulations.</p> <p>The applicable paragraphs of the Transport Regulations for packages containing 0.1 kg or more of uranium hexafluoride are provided in a matrix in Annex I.</p>
1.7. PACKAGE OPERATIONS
<p>The PDSR should include the measures to be implemented to assure <u>ensure</u> compliance with the requirements established in para. 420 of the Transport Regulations.</p>
1.8. MAINTENANCE
<p>The PDSR should include the measures to be implemented to assure <u>ensure</u> compliance with ISO 7195 [13] <u>[12]</u>, as required by para. 631 of the Transport Regulations.</p>
1.9. GAP ANALYSIS PROGRAMME
<p>For packages that are to be used for shipment after storage, the PDSR should include a gap analysis programme describing a systematic procedure for a periodic evaluation of changes of regulations, changes in technical knowledge and changes of <u>in</u> the state of the package design during storage (see also paras 613A.5, 809.3 and 809.4 of SSG-26 (Rev. 1) [2]).</p>
1.10. MANAGEMENT SYSTEM
<p>The PDSR should include the specification of <u>specify</u> the management system that is established and implemented by the package designer, as required in <u>accordance with</u> para. 306 of the Transport Regulations, <u>to ensure</u> to <u>demonstrate</u> compliance with the relevant provisions of the Transport Regulations.</p>

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TABLE 6. ~~ADDITIONAL INFORMATION~~ PACKAGE DESIGN SAFETY REPORT FOR PACKAGES CONTAINING 0.1 kg OR MORE OF URANIUM HEXAFLUORIDE, ~~ADDITIONAL INFORMATION~~

<p>The management system should cover the following activities:</p> <ul style="list-style-type: none">(a) Package design, PDSR, documentation, <u>and</u> records;(b) Manufacture and testing of the packaging;(c) Operation (<u>i.e. preparation</u>, loading, <u>transport</u>carriage, storage in transit, <u>receipt and shipment after storage</u>, unloading <u>and receipt</u>);(d) Maintenance, repair and inspection of the packaging. <p>The management system should be commensurate with the complexity of the package design and should include a reliable document control system.</p> <p>The management system should include the descriptions of the actions to be performed to check the compliance with the PDSR of the documents relating to package operation (e.g. manufacture<u>manufacturing</u>, operation or maintenance manual<u>manuals</u>) <u>with the PDSR</u> and <u>should also cover</u> the management of deviations detected in the framework of any transport activity.</p> <p>For all components important to safety, this section of the PDSR should define the parameters to be guaranteed and the level of controls <u>required</u> during manufacturing and maintenance.</p> <p>More<u>Further</u> recommendations on the management system for transport are provided in TS-G-1.4 [6].</p>
<h3>1.11 PACKAGE ILLUSTRATION</h3>
<p>A reproducible illustration should be provided showing the make-up of the package, including shock absorbers and devices for thermal protection, if applicable.</p> <p>The illustration should indicate at least the overall outside dimensions and the masses for<u>mass of the package when</u> empty and <u>when</u> loaded conditions.</p>
<h2>Part 2</h2>
<h3>2.1. STRUCTURAL ANALYSIS</h3>
<p>The general considerations for all technical analyses should be taken into account when performing the structural analysis to demonstrate compliance with the requirements established in paras<u>para</u>. 632-(a) and (b) of the Transport Regulations.</p> <p>The assessment of the mechanical behaviour (including, as applicable, analysis of thermal stresses, fatigue, brittle fracture and creep) for routine, normal and accident conditions of transport should include the following:</p> <ul style="list-style-type: none">(a) The components of the containment system;(b) Any other package components (e.g. shock absorbing components, packaging components that provide thermal protection) whose performance may have a consequential effect upon<u>on</u> (a). <p>The<u>When performing the structural analysis for packages containing 0.1 kg or more of uranium hexafluoride, the</u> following points should be taken into account<u>considered</u>:</p> <p>(1) General remarks<u>considerations</u>:</p>

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TABLE 6. ~~ADDITIONAL INFORMATION~~ PACKAGE DESIGN SAFETY REPORT FOR PACKAGES CONTAINING 0.1 kg OR MORE OF URANIUM HEXAFLUORIDE, ADDITIONAL INFORMATION

<p>(i) The mechanical properties of the materials considered in the safety demonstration should be representative of the range of mechanical properties of the package components considering, with account taken of the temperature range applicable to the type of package.</p> <p>(ii) The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material should be analysed, considering the temperature range applicable to the type of package and the range of moisture conditions that is likely to be encountered during transport;.</p> <p>(iii) The safety against brittle fracture should be analysed, considering the temperature range applicable to the type of package;.</p> <p>(iv) It should be verified that the content is not liable to damage the containment system;.</p> <p>(v) The condition of the containment system should be determined assessed to demonstrate compliance with <u>the specifications in item 2.3</u> of the PDSR within for the temperature range applicable to the type of package;.</p> <p>(vi) The ability to withstand the maximum pressure during the thermal test (elevation of pressure of <u>UF₆ uranium hexafluoride</u>) should be demonstrated.</p> <p>(2) Considerations for experimental mechanical testing:</p> <p>(i) The package orientations should be determined in accordance with paras. 722.4 and 722.6 of SSG-26 (Rev. 1) [2]. The orientations should maximize the loading of the package (in terms of stress, strain, acceleration and deformation)), with consideration of the different package components (e.g. cylinder body, shock absorber) and of the protection objective (<u>i.e.</u> containment).</p> <p><u>(i)</u> For package orientations, the following tests should be considered, as appropriate:</p> <ul style="list-style-type: none">— Tests that maximize the stresses and acceleration (<u>e.g. flat, slap down</u>)); the. The greater the impact area, the harder the impact, under the assumption of constant stiffness per unit area;.— Tests that maximize the deformation (e.g. on corner corners, on edges)); the. The smaller the impact area, the greater the crushing;.— Tests that maximize the damages damage to valves, notably by a puncture bar;.— Tests that maximize the risk of perforation by a puncture bar, possibly oblique); if. If the <u>impacted</u> package impacted surface is oblique with respect to the puncture bar, the initial impact takes place on an edge of the puncture bar and the risk of perforation is much higher. <p>(ii) For reduced scale models, geometry and material properties similar to the original design, or conservative geometry and material properties, should be used.</p> <p>(iii) The results of the drop test with reduced scale models should be assessed to guarantee that they cover, or are transferable to, the original design.</p> <p>(iv) The representativeness of drop Drop tests performed with reduced scale models should be demonstrated <u>as representative</u> for the following parameters and components:</p> <ul style="list-style-type: none">— Drop heights: It might be necessary to increase the drop heights during testing to simulate the total potential energy that would have been received by the package at full scale. This should be considered for drop tests where the characteristic deformation of the structure is not negligible in comparison to the drop height;.— Appropriate geometry scaling of all components; (<u>e.g. lids, nuts and bolts, grooves for the seals, valves, plugs</u>).
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<ul style="list-style-type: none">— The scaling of tightening torques for bolts of the reduced scale model should take into account the dispersion of friction conditions, <u>the</u> precision of torques and <u>the</u> technical limitations in an exact geometrical and physical scaling of the containment system components;— Welding seams should be similar for scale model and package design;— In case ofFor reduced scale model drop testing with significant deformations of shock absorbers, the original package performance should be carefully justified. <p>(v) The experimental mechanical tests should be conducted and reported in accordance with the management system. The test report should address the verification of the package before testing, the description of the test site, the equipment used for measurements and its calibration data, and the results of the measurements performed. This report should also contain pictures showing and explaining the performing conditions of<u>under which</u> the tests were performed and their results.</p> <p>(3) Considerations for calculations:</p> <ul style="list-style-type: none">(i) See point (2)(i) above;(ii) Validated computer codes should be used. Input parameters (e.g. material laws, characteristic values, boundary conditions) should describe sufficiently and precisely the real technical and/or physical problems, and the use of these parameters should be justified;(iii) If uncertainties exist regarding important input parameters (e.g. material laws), conservative design calculations <u>—</u> including the possible range of material properties <u>—</u> should be performed;(iv) Data used (e.g. material laws, boundary conditions, load assumptions etc.) and calculation results should be documented comprehensively.
<h2>2.2. THERMAL ANALYSIS</h2>
<p>The temperature<u>temperature</u> of the package components should be assessed in accident conditions of transport (see para. 659(b) of the Transport Regulations). The thermal analysis should include the thermal behaviour of the following components:</p> <ul style="list-style-type: none">(a) The components of the containment system;(b) The package components whose performance will have a consequential effect upon<u>on</u> (a). <p>The demonstration of compliance should be limited to show<u>showing</u> compliance with para. 632(c) of the Transport Regulations.</p> <p>The following remarks should be taken into account<u>considered</u>:</p> <ul style="list-style-type: none">(1) The effects of insulation on<u>over</u> a period of 12 hours in accordance with para. 657 of the Transport Regulations;(2) Consideration of the<u>The</u> solar insolation before and after the thermal test, as defined in para. 728 of the Transport Regulations;(3) The justification for simplifying the assumptions (e.g. <u>absence of trunnions</u>) used for calculation in<u>under</u> normal and accident conditions of transport;(4) The analysis of the package in accident conditions of transport in the position (<u>i.e.</u> horizontal or vertical) less<u>least</u> resistant to thermal tests;(5) The value of the surface absorptivity coefficient of the package. The surface absorptivity coefficient should not be lower than 0.8 (see para. 728(a) of the Transport Regulations) during

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TABLE 6. ~~ADDITIONAL INFORMATION~~ PACKAGE DESIGN SAFETY REPORT FOR PACKAGES CONTAINING 0.1 kg OR MORE OF URANIUM HEXAFLUORIDE, ADDITIONAL INFORMATION

<p>and after the thermal test to account for deposits upon on the package surface. The surface absorptivity coefficient should also not be lower than the possible maximum value of the emissivity coefficient in routine conditions of transport;.</p> <ol style="list-style-type: none">(6) The evaluation of the minimum and maximum temperatures of the various components of the packaging, taking account of all the possible positions for the radioactive contents;.(7) The justification that the concentration of oxygen present in the furnace is controlled and in conformity with that obtained in a hydrocarbon fuel–air fire, when the thermal test is madeconducted in a furnace and when it is noted that some package components burn. In addition, control of heat input should be considered thoroughly;.(8) The influence of combustible materials that generate additional heat input and affect the fire duration beyond the thermal test;.(9) The safety margins on temperature results derived using numerical modelling commensurate with the uncertainty associated towith the numerical model.
<p>2.3. CONTAINMENT DESIGN ANALYSIS</p>
<p>Compliance with parapara. 632-(a) and (b) of the Transport Regulations should be demonstrated in the structural analysis. Compliance with para. 632-(c) of the Transport Regulations should be demonstrated in the thermal analysis.</p>

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STEP 12

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STEP 12

ANNEX I

MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Table I-1 shows the applicable paragraphs of the Transport Regulations to be included in the demonstration of compliance for each package type and additional provisions for packages containing fissile material and packages containing 0.1 kg or more of uranium hexafluoride.

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) II ^a	Package Type ^{type}							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
<u>ACTIVITY LIMITS AND CLASSIFICATION</u> <u>Activity limits and classification</u>										
408-411		X	X	X						<u>Low specific activity (LSA)</u> classification and activity limits, § <u>Paragraph 410</u> : transport by air
412-414		X	X	X						<u>Surface contaminated object (SCO)</u> classification and activity limits
415, 416	X				X	X				If special form radioactive material or low dispersible radioactive material is present, add reference to approval certificate
417, 418								X		Classification as fissile material, exceptions and restrictions
419, 420									X	Classification as uranium hexafluoride and restrictions
422-427	X									Classification as excepted package
429-430					X					Activity limit for type ^{Type} A package

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TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H ^a	Package Type ^{type}							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
431, 432							X			Classification as type ^{Type} C package and activity limits
433						X				Activity limits for type ^{Type} B(U) and Type ^{Type} B(M) packages by air
REQUIREMENTS AND CONTROLS FOR TRANSPORT <u>Requirements and controls for transport</u>										
501		X	X	X	X	X	X			Requirements before first shipment
502, 503	X	X	X	X	X	X	X			Requirements before each shipment
504		X	X	X	X	X	X			Additional items in the package
507	X	X	X	X	X	X	X			Other dangerous properties
515- 5 , 516	X									Excepted package requirements
517		X	X	X						Dose rate of unshielded LSA or SCO
521		X	X	X						Package for LSA material and SCO
522		X	X	X						Activity limit for LSA and SCO
526		X	X	X	X	X	X	X		H ^T <u>transport index</u> and <u>criticality safety index (CSI)</u> limits
527, 528		X	X	X	X	X	X			Dose rate at contact of a package

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H ^a	Package Type ^{type}							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
533	X	X	X	X	X	X	X			Marking
534		X	X	X						
535, 536						X	X	X	X	
575		X	X	X	X	X	X			Transport by sea
578						X				Transport by air for type ^{Type} B(M) package
<u>REQUIREMENTS FOR RADIOACTIVE MATERIAL AND FOR PACKAGINGS AND PACKAGES</u> Requirements for radioactive material and for packagings and packages										
606	X	X	X	X	X	X	X			<u>Requirements for fissile excepted classification</u>
606 607-618	X	X	X	X	X	X	X			General provisions
619 -621	X	X	X	X	X	X	X			Transport by air
622	X									Excepted packages
623		X								Type IP-1
624			X							Type IP-2
625				X						Type IP-3
626			X							Alternative requirements for Type IP-2

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H ^a	Package Type ^{type}							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
627 –630			X	X						Alternative requirements
631 –634									X	Uranium hexafluoride
635 636		X	X	X	X	X	X	X		Minimal <u>Minimum</u> dimensions
637				X	X	X	X	X		Seal
638 –647				X	X	X	X			Type A
648				X	X	B) <u>ONLY pa</u> <u>ra.</u> <u>648(b)</u> <u>only</u>	B) <u>ONLY pa</u> <u>ra.</u> <u>648(b)</u> <u>only</u>			Type A– ₂ release criteria
649				X	X	X	X			Type A– ₂ liquids
650					X					Type A– ₂ liquids
651					X					Type A– ₂ gases
652						X				Type B(U)
653 –657						X	X			Type B(U)
658 –660						X				Type B(U)

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H ^a	Package Typ ^e type							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
661–666						X	X			Type B(U)
667, 668						X				Type B(M) only
669–672							X			Type C
673								X		Fissile material
674, 675								X		CSI control with exception from C Acompetent authority approval of package design for fissile material
676– 686								X		Packages containing fissile material
TEST PROCEDURES Test procedures										
701	X	X	X	X	X	X	X	X	X	Demonstration of compliance
702			X	X	X	X	X	X	X	Assessment after tests
713–715			X	X	X	X	X	X	X	Preparation of a package for testing
716			X	X	X	X	X	X	X	Integrity of containment, and shielding and , assessing criticality safety
717			X	X	X	X	X	X	X	Target for drop tests
718									X	Structural test

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H^a	Package Typ type							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
719- 2 720				X	X	X	X	X	X	General provisions for normal conditions tests
721				X	X	X	X	X		Water spray test
722			X	X	X	X	X	X	X	Free drop test
723			X	X	X	X	X	X		Stacking test
724				X	X	X	X	X		Penetration test
725					X					Additional tests for Type A (liquids and gases)
726						X	X	X		General provisions for accident conditions tests
727-(a)						X	X	X		9 m drop test
727-(b)						X		X		Drop test onto a bar
727-(c)						X	X	X		Dynamic crush test
728						X		X	X	Thermal test
729						X		X		Water immersion test
730						X	X			Enhanced water immersion test
731- 732 733								X		Water leakage test

Table I.1. Matrix of Applicable Requirements of the Transport Regulations for Different Package Types and Additional Provisions

TABLE I-1. MATRIX OF APPLICABLE REQUIREMENTS OF THE TRANSPORT REGULATIONS FOR DIFFERENT PACKAGE TYPES AND ADDITIONAL PROVISIONS

Paras of SSR-6 (Rev. 1) H^a	Package Type type							Additional provisions		Remarks
	Excepted	IP-1	IP-2	IP-3	A	B(U), B(M)	C	Fissile	UF ₆	
734							X			General provisions for Type C package tests
735							X			Puncture/ <u>tearing</u> test
736							X			Enhanced thermal test
737							X			Impact test

^a INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2018 Edition, IAEA Safety Standards Series No. SSR-6 (Rev. 1), IAEA, Vienna (2018).

ANNEX II
REFERENCE DOCUMENTS USED BY COMPETENT AUTHORITIES FOR
TECHNICAL ASSESSMENTS

Table II-1 provides a list of reference publications used by different competent authorities for the technical assessment of package designs.

TABLE II-1. REFERENCE DOCUMENTS USED BY COMPETENT AUTHORITIES FOR TECHNICAL ASSESSMENTS

Canada	<p>ISO 2919 « Sealed radioactive sources — General requirements <u>Requirements</u> and classification <u>Classification</u></p> <p>ISO 9978 « Sealed Radioactive Sources — Leak Test Methods²</p> <p>ISO 7195 « Packaging of uranium hexafluoride for transport²</p> <p>ANSI N14.1 <u>ANSI N14.1</u> «Uranium Hexafluoride —for Transport</p> <p><u>ANSI N14.1, Uranium Hexafluoride — Packaging for Transport</u>²</p> <p>ISO 12807 « Safe transport <u>Transport</u> of radioactive materials <u>Radioactive Materials</u> — Leakage testing <u>Testing</u> on packages <u>Packages</u></p> <p>ANSI N14.5 « American National Standard for Radioactive Materials — — Leakage Tests on Packages for Shipment²</p> <p>ANSI N14.7 « Guidance for Packaging Type A Quantities of Radioactive Materials²</p> <p>RD-364, Joint Canada — United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages</p> <p>ISO 9001, Quality management systems <u>Management Systems</u> — Requirements</p>
France	<p>ASN Guide N° <u>No.</u> 7 — Transport — Applicant's guide related to <u>applications for shipment approval and certificate of packages</u> package design or radioactive materials for civil use on usage transported by public domain</p> <p>Vol. 1: Demandes d'agrément et d'approbations d'expéditions — Vol. 2: Dossiers de sûreté des modèles de colis, guide européen (Package Design Safety Reports) — Vol.3: Conformité des modèles de colis non soumis à agrément <u>roads, by water or by rail</u></p> <p>ISO 2919 « Sealed radioactive sources — General requirements and classification »</p> <p>ISO 9978 « Sealed Radioactive Sources — <u>General Requirements and Classification</u></p> <p>ISO 9978 <u>ISO 9978</u>, Sealed Radioactive Sources — Leak Test Methods »</p> <p>ISO 7195 « Packaging of uranium hexafluoride for transport »</p> <p>ANSI N14.1 <u>ANSI N14.1</u> «Uranium Hexafluoride —for Transport</p> <p><u>ANSI N14.1, Uranium Hexafluoride — Packaging for Transport</u> »</p> <p>ISO 12807 « Safe transport <u>Transport</u> of radioactive materials <u>Radioactive Materials</u> — Leakage testing <u>Testing</u> on packages <u>Packages</u> »</p>

	<p>ISO 10276—«<u>Trunnions for packages used to transport radioactive material</u>»<u>Packages Used to Transport Radioactive Material</u></p> <p>NF EN 25-030—«<u>Éléments de fixation — Assemblages vissés — Partie 1: règles générales de conception, de calcul et de montage</u>»</p> <p>VDI 2230—«<u>Systematic calculation</u><u>Calculation of high duty bolted joints</u>»<u>High Duty Bolted Joints</u></p> <p><u>YOUNG, W.C., ROARK's Formulas for stress</u><u>Stress and strain</u><u>Strain, 7th edition, Warren C. YOUNG</u><u>Edn, McGraw-Hill, New York (1984)</u></p> <p><u>CEA, Catalogue PMDS, CEA, Tome I</u>—«<u>Ecrans de protection contre les rayonnements ionisants</u>»</p> <p>NF EN 10228-3, «<u>Essais non destructifs des pièces forgées en acier — contrôle par ultrasons des pièces forgées en aciers ferritiques et martensitiques</u>»</p>
Germany	<p>ANSI N14.1—«<u>Uranium Hexafluoride — Packaging for Transport</u>»²²</p> <p>BAM-GGR 007—«<u>Leitlinie zur Verwendung von Gusseisen mit Kugelgraphit für Transport- und Lagerbehälter für radioaktive Stoffe</u>»</p> <p>BAM-GGR 008—«<u>Richtlinie für numerisch geführte Sicherheitsnachweise im Rahmen der Bauartprüfung von Transport- und Lagerbehältern für radioaktive Stoffe</u>»</p> <p>BAM-GGR 011—«<u>Quality Assurance Measures of Packagings for Competent Authority Approved Package Designs for the Transport of Radioactive Material</u>»²²</p> <p>BAM-GGR 012—«<u>Leitlinie zur Berechnung der Deckelsysteme und Lastanschlagsysteme von Transportbehältern für radioaktive Stoffe</u>»</p> <p>DIN 25415 part 1—«<u>Radioactively contaminated surfaces—Contaminated Surfaces — Method for testing</u><u>Testing and assessing</u><u>Assessing the ease</u><u>Ease of decontamination</u>»<u>Decontamination</u></p> <p>FKM₃ Guideline «<u>Fracture Mechanics Proof of Strength for Engineering Components</u>»²²</p> <p>FKM₃ Richtlinie «<u>Rechnerischer Festigkeitsnachweis für Maschinenbauteile</u>»²²</p> <p>ISO 2919—«<u>Sealed radioactive sources—Radioactive Sources — General requirements</u><u>Requirements and classification</u>»<u>Classification</u></p> <p>ISO 7195—«<u>Packaging of uranium hexafluoride</u><u>Uranium Hexafluoride for transport</u>»<u>Transport</u></p> <p>ISO 9978—«<u>Sealed Radioactive Sources — Leak Test Methods</u>»²²</p> <p>ISO 12807—«<u>Safe transport</u><u>Transport of radioactive materials—Radioactive Materials — Leakage testing</u><u>Testing on packages</u>»<u>Packages</u></p> <p>KTA 3905—«<u>Load Attaching Points on Loads in Nuclear Power Plants</u>»²²</p> <p><u>BRITISH ENERGY GENERATION, R6 — Assessment of the Integrity of Structures Containing Defects. British Energy Generation Ltd.</u></p> <p>VDI 2230—«<u>Systematic calculation</u><u>Calculation of high duty bolted joints</u>»<u>High Duty Bolted Joints</u></p>

	<p>DIN 25712—“<u>Criticality safety taking</u>Safety Taking into accountAccount the burnupBurnup of fuelFuel for transportTransport and storageStorage of irradiated light water reactor fuel assembliesIrradiated Light Water Reactor Fuel Assemblies in casksCasks”</p> <p>ICRP Publication 103, the—2007 Recommendations of the International Commission on Radiological Protection</p> <p>ICRP <u>Publication</u> 74—“<u>Conversion Coefficients for use</u>Use in Radiological Protection against External Radiation”</p>
<p>United States of America</p>	<p>American Society of Mechanical Engineers, “ASME Boiler and Pressure Vessel Code, Section III, Division 3, — Containment Systems and Transport Packagings Forfor Spent Nuclear Fuel and High-Level Radioactive Waste,” (2015 or later editions)</p> <p>American Society of Mechanical Engineers, “ASME Boiler and Pressure Vessel Code, Section III, Division 1, — Containment Systems and Transport Packagings Forfor Spent Nuclear Fuel and High-Level Radioactive Waste,” (2015 or later editions)</p> <p>American Nuclear Society, ANSI/ANS 6.1.1, “American National Standard for Neutron and Gamma-Ray Fluence to Dose Factors,” (1977)</p> <p>ANSI N14.5-2014—“<u>American National Standard for Radioactive Materials—</u> — Leakage Tests on Packages for Shipment.” 2014.</p> <p>ANSI N14.1-2019; Uranium Hexafluoride Packagings Transport —2019</p> <p><u>NRC Draft Regulatory Issue Summary RIS 2015-XXX, Considerations in Licensing High Burn-up Spent Fuel in Dry Storage and Transportation</u></p> <p><u>NRC Regulatory Guide 7.9, “Standard Format and Content of Part 71 Applications for Approval of Packages for Radioactive Material”, revision 2,</u> (2005)</p> <p><u>NRC Interim Staff Guidance ISG 8, Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transport and Storage Casks, revision 3</u></p> <p>NUREG-2216, “Standard Review Plan for Transportation Packages for Spent Fuel and Radioactive Material”</p> <p>NUREG/CR-5661, “Recommendations for Preparing the Criticality Safety Evaluation of Transportation Packages”</p> <p>NUREG/CR-6361, “Criticality Benchmark Guide for Light–Water-Reactor Fuel in Transportation and Storage Packages”</p> <p>Interim Staff Guidance ISG 8, Revision 3, “Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transport and Storage Casks”</p> <p>NRC Draft Regulatory Issue Summary RIS 2015-XXX “Considerations in Licensing High Burn-up Spent Fuel in Dry Storage and Transportation”</p> <p>NUREG/CR-6802, “Recommendations for Shielding Evaluations for Transport &and Storage Packages”</p> <p>NUREG/CR-6487, “Containment Analysis for Type B Packages Used to Transport Various Contents”</p>

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ANNEX III
STRUCTURE OF THE PACKAGE DESIGN SAFETY REPORT FOR APPENDICES I–VI

Table III–1 shows the structure of the PDSR for the packages addressed in Appendices I–VI of this Safety Guide.

TABLE III–1. STRUCTURE OF THE PACKAGE DESIGN SAFETY REPORT FOR APPENDICES I–VI

APPENDIX I — TABLE 1 PDSR FOR EXCEPTED PACKAGES		APPENDIX II — TABLE 2: PDSR FOR INDUSTRIAL PACKAGES		APPENDIX III — TABLE 3: PDSR FOR TYPE A PACKAGES		APPENDIX IV — TABLE 4: PDSR FOR TYPE B(U), TYPE B(M) AND TYPE C PACKAGES		APPENDIX V — TABLE 5: ADDITIONAL INFORMATION PDSR FOR PACKAGES CONTAINING FISSILE NUCLIDES, ADDITIONAL INFORMATION		APPENDIX VI — TABLE 6: ADDITIONAL INFORMATION FOR PACKAGES CONTAINING URANIUM HEXAFLUORIDE, ADDITIONAL INFORMATION	
Part 1		Part 1		Part 1		Part 1		Part 1		Part 1	
1.1.	ADMINISTRATIVE INFORMATION	1.1.	ADMINISTRATIVE INFORMATION	1.1.	ADMINISTRATIVE INFORMATION	1.1.	ADMINISTRATIVE INFORMATION	1.1.	ADMINISTRATIVE INFORMATION	1.1.	ADMINISTRATIVE INFORMATION
1.2.	SPECIFICATION OF THE CONTENTS	1.2.	SPECIFICATION OF the THE CONTENTS	1.2.	SPECIFICATION OF THE CONTENTS	1.2.	SPECIFICATION OF THE CONTENTS	1.2.	SPECIFICATION OF THE CONTENTS	1.2.	SPECIFICATION OF THE CONTENTS
1.3.	SPECIFICATION OF THE PACKAGING	1.3.	SPECIFICATION OF THE PACKAGING	1.3.	SPECIFICATION OF THE PACKAGING	1.3.	SPECIFICATION OF THE PACKAGING	1.3.	SPECIFICATION OF THE PACKAGING	1.3.	SPECIFICATION OF THE PACKAGING
		1.4.	AGEING CONSIDERATIONS	1.4.	AGEING CONSIDERATIONS	1.4.	AGEING CONSIDERATIONS	1.4.	AGEING CONSIDERATIONS	1.4.	AGEING CONSIDERATIONS
						1.5.	CONDITIONS FOR TECHNICAL ANALYSES	1.5.	CONDITIONS FOR TECHNICAL ANALYSES	1.5.	CONDITIONS FOR TECHNICAL ANALYSES
1.4.	COMPLIANCE WITH REGULATORY REQUIREMENTS	1.5.	COMPLIANCE WITH REGULATORY REQUIREMENTS	1.5.	COMPLIANCE WITH REGULATORY REQUIREMENTS	1.6.	COMPLIANCE WITH REGULATORY REQUIREMENTS	1.6.	COMPLIANCE WITH REGULATORY REQUIREMENTS	1.6.	COMPLIANCE WITH REGULATORY REQUIREMENTS
1.5.	PACKAGE OPERATIONS	1.6.	PACKAGE OPERATIONS	1.6.	PACKAGE OPERATIONS	1.7.	PACKAGE OPERATIONS	1.7.	PACKAGE OPERATIONS	1.7.	PACKAGE OPERATIONS
1.6.	MAINTENANCE	1.7.	MAINTENANCE	1.7.	MAINTENANCE	1.8.	MAINTENANCE	1.8.	MAINTENANCE	1.8.	MAINTENANCE
		1.8.	GAP ANALYSIS PROGRAMME	1.8.	GAP ANALYSIS PROGRAMME	1.9.	GAP ANALYSIS PROGRAMME	1.9.	GAP ANALYSIS PROGRAMME	1.9.	GAP ANALYSIS PROGRAMME
1.7.	MANAGEMENT SYSTEM	1.9.	MANAGEMENT SYSTEM	1.9.	MANAGEMENT SYSTEM	1.10.	MANAGEMENT SYSTEM	1.10.	MANAGEMENT SYSTEM	1.10.	MANAGEMENT SYSTEM
				1.10.	PACKAGE ILLUSTRATION	1.11.	PACKAGE ILLUSTRATION	1.11.	PACKAGE ILLUSTRATION	1.11.	PACKAGE ILLUSTRATION
Part 2		Part 2		Part 2		Part 2		Part 2		Part 2	

2.1.	STRUCTURAL ANALYSIS	2.1.	STRUCTURAL ANALYSIS	2.1.	STRUCTURAL ANALYSIS	2.1.	STRUCTURAL ANALYSIS	2.1.	STRUCTURAL ANALYSIS	2.1.	STRUCTURAL ANALYSIS
		2.2.	THERMAL ANALYSIS	2.2.	THERMAL ANALYSIS	2.2.	THERMAL ANALYSIS	2.2.	THERMAL ANALYSIS	2.2.	THERMAL ANALYSIS
		2.3.	CONTAINMENT DESIGN ANALYSIS	2.3.	CONTAINMENT DESIGN ANALYSIS	2.3.	CONTAINMENT DESIGN ANALYSIS	2.3.	CONTAINMENT DESIGN ANALYSIS	2.3.	CONTAINMENT DESIGN ANALYSIS
2.2.	DOSE RATE ANALYSIS	2.4.	DOSE RATE ANALYSIS	2.4.	DOSE RATE ANALYSIS	2.4.	DOSE RATE ANALYSIS				
		2.5.	CRITICALITY SAFETY ANALYSIS	2.5.	CRITICALITY SAFETY ANALYSIS	2.5.	CRITICALITY SAFETY ANALYSIS	2.4.	CRITICALITY SAFETY ANALYSIS		
						2.6.	OTHER ANALYSES				

CONTRIBUTORS TO DRAFTING AND REVIEW

Boyle, R.	US-United States Department of Transportation, United States of America
Capadona, N.	International Atomic Energy Agency
Chrupek, T.	Nuclear Safety Authority, France
Dejean, C.	Institute for Radiological Protection and Nuclear Safety, France
Edwards, W.	World Nuclear Transport Institute
Elechosa, C.	Nuclear Regulatory Authority, Argentina
Ferran, G.	Nuclear Safety Authority, France
Fiaccabrino, V.	Nuclear Safety Authority, France
Fukuda, T.	Nuclear Regulation Authority, Japan
Garg, R.	Canadian Nuclear Safety Commission, Canada
Gauthier, F.	Institute for Radiological Protection and Nuclear Safety, France
Hirose, M.	Nuclear Regulation Authority, Japan
Katona, T.	Hungarian Atomic Energy Authority, Hungary
Komann, S.	Federal Institute for Material Materials Research and testing Testing , Germany
Konnai, A.	National Maritime Research Institute, Japan
Krochmaluk, J.	Institute for Radiological Protection and Nuclear Safety, France
Lizot, M.-T.	Institute for Radiological Protection and Nuclear Safety, France
Malesys, P.	World Nuclear Transport Institute
Moutarde, M.	Institute for Radiological Protection and Nuclear Safety, France
Nöring, R.	World Nuclear Transport Institute
Pilecki, L.	Canadian Nuclear Safety Commission, Canada
Pstrak, D.	Nuclear Regulatory Commission, United States of America
Pilecki, L.	Canadian Nuclear Safety Commission, Canada
Ramsay, J.	Canadian Nuclear Safety Commission, Canada
Reiche, I.	Federal Office for Radiation Protection, Germany
Sampson, M.	Nuclear Regulatory Commission, United States of America
Sarkar, S.	Australian Radiation Protection and Nuclear Safety Agency, Australia
Sert, G.	Institute for Radiological Protection and Nuclear Safety, France
Vaclav, J.	Nuclear Regulatory Authority of the Slovak Republic, Slovakia
Yagihashi, H.	Nuclear Regulation Authority, Japan