DS-493
2016-06-17

IAEA SAFETY STANDARD SERIES No. SSG-xx

**Status: Approved by TRANSSC in June 2016 for 120-day MS Comments**

**SPESS Step 8**

# FORMAT AND CONTENT OF THE PACKAGE DESIGN SAFETY REPORT (PDSR) FOR THE TRANSPORT OF RADIOACTIVE MATERIAL

SPECIFIC SAFETY GUIDE

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# SECTION I

# INTRODUCTION

## BACKGROUND

1.1. For each design of a package for the transport of radioactive material it is necessary to demonstrate compliance with national and international regulations as applicable. For package designs which need approval by a competent authority the documentary evidence of compliance with the regulations is the basis for the application for package design approval, and it is commonly known as a Package Design Safety Report (PDSR). For packages not requiring competent authority approval the documentary evidence of the compliance of the package design with all applicable requirements is also necessary. It is proposed that for these package designs the same discipline of approach is adopted as for packages requiring competent authority approval, with the scope and technical content set at the appropriate levels to demonstrate compliance with the regulatory requirements. Hereafter, every such documentary evidence of the compliance of a package design with all applicable requirements will be called PDSR, independently of the package type.

1.2. This publication is based on the IAEA SSR-6 Regulations [1] upon which the United Nations Recommendations on the Transport of Dangerous Goods [2] and, after transposal, international, regional and national regulations are based, for all modes of transport.

1.3. A generic structure and contents of a PDSR, namely Part 1 and Part 2, which apply to all package types are presented in Figure 1. The contents are described in a comprehensive way to cover all important aspects. Some of these aspects may not be applicable to a specific package type and details can be found in the annexes.

1.4. The package design safety report is a controlled document. It includes a record of its compilation and review and its approval by the package designer. Each individual document in Part 1 of the package design safety report is a controlled document and is subject to approval for issue by the author/owner of the document and the package designer. Each individual document in Part 2 of the package design safety report is a controlled document and is subject to approval for issue by a technical specialist responsible for the technical discipline being assessed.

## OBJECTIVE

1.5. This safety guide is intended to assist in the preparation of the PDSR to demonstrate compliance of a design of a package for the transport of radioactive material with the regulatory requirements.

1.6. This safety guide does not replace the regulations or limit their application. Rather it proposes for each package type a structure and a typical content for a PDSR to enable the applicant, in case of a package design subject to competent authority approval, or the package designer and/or user, in case of a package design not requiring competent authority approval, to demonstrate compliance with the provisions of SSR-6 applicable to the respective package type.

1.7. This safety guide does not relieve the package designer from any additional analysis need associated with the concerned specific package design. If there are any discrepancies between this document and the regulations, the requirements in the regulations apply.

## SCOPE

1.8. It covers package designs requiring competent authority approval:

- Type B(U).
- Type B(M).
- Type C.
- Packages containing fissile material not excepted from the requirements of the regulations that apply to fissile material.
- Packages designed to contain 0.1 kg or more of uranium hexafluoride.

This safety guide also covers package designs not requiring competent authority approval:

- Excepted package.
- Industrial package
  - Type IP-1.
  - Type IP-2
  - Type IP-3
- Type A package.

## STRUCTURE

1.9. This publication is structured so that Section II describes the information that needs to be specified regarding administrative topics, package contents, packaging details, performance, compliance with regulations, operation and maintenance; Section III provides guidance on the detailed technical analysis; Section IV provides clarification regarding definitions and abbreviations. Appendices I to VI provide further guidance for the scope of the contents of a PDSR specifically for each package type. Annex I provides a matrix of paragraphs of SSR-6 applicable to each package design, for packages designed to meet the requirements stated in previous Editions of the IAEA Transport Regulations [1], as allowed by transitional conditions, the matrix has to be adapted to the appropriate edition.; and Annex II provides a list of reference documents used by competent authorities for technical assessment.

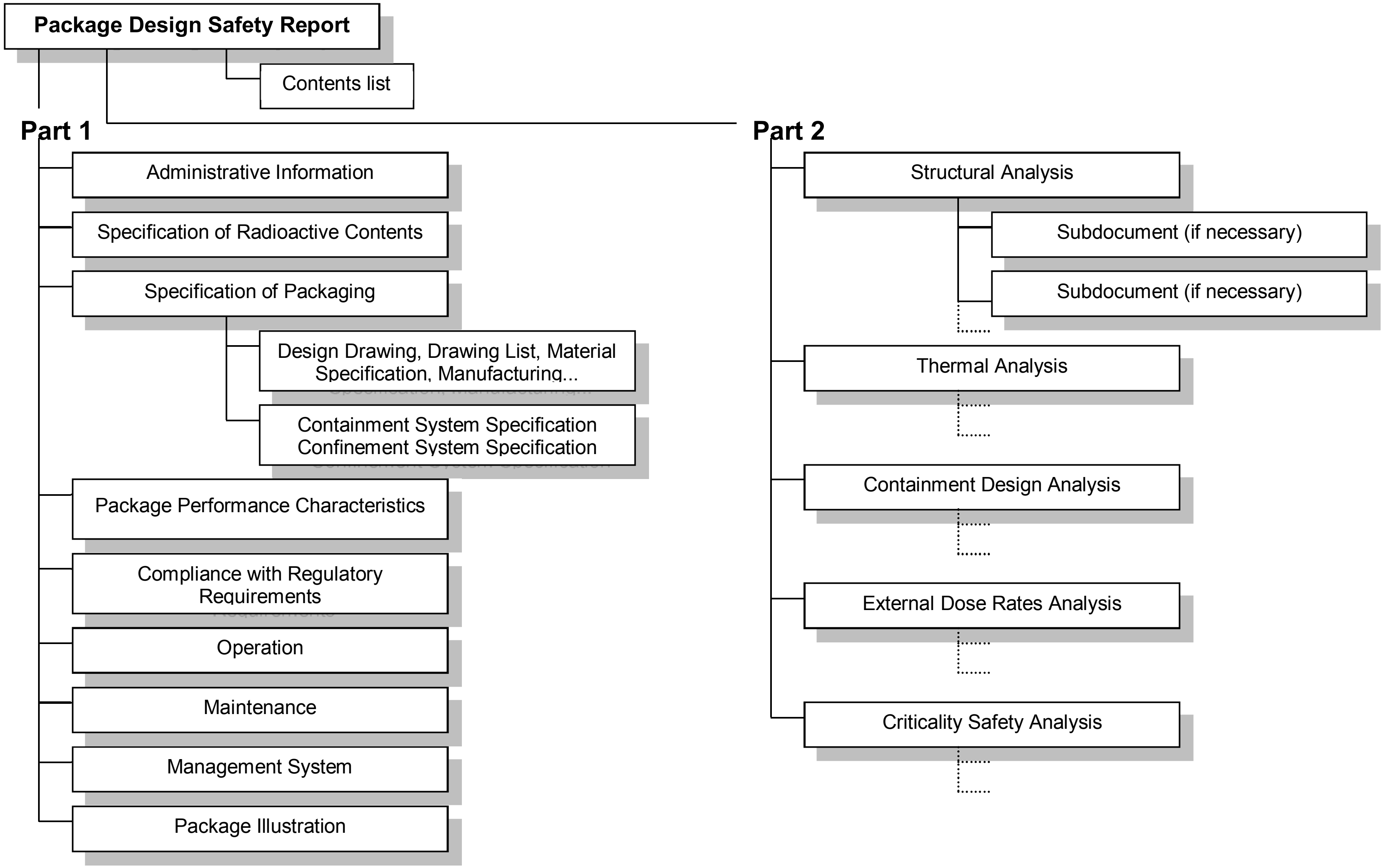


FIGURE 1: Structure of Package Design Safety Report

## SECTION II

## PACKAGE DESIGN SAFETY REPORT: PART 1

2.1.Part 1 of the PDSR should include the following information:

CONTENTS LIST OF THE PDSR

2.2. The contents of the PDSR, Part 1 and Part 2, should be listed including the issue status of each individual document included in the PDSR.

ADMINISTRATIVE INFORMATION

2.3. The following administrative information should be included:

a) Colloquial name of package, if applicable
b) Identification of package designer (name, address, contact details)
c) Type of package
d) Packaging / package design identification and restrictions in packaging serial number(s) (if applicable)
e) Modes of transport for which the package is designed and any operational restrictions)
f) Reference to applicable regulations, including the edition of the IAEA Regulations for the Safe Transport of Radioactive Material to which the package design is referring, if necessary.

SPECIFICATION OF CONTENTS

2.4. Detailed descriptions of the permitted contents of the package design should be defined by stating, but not limited to, the following information, as applicable (see annexes):

a) Nuclides / nuclide composition; daughter radionuclides,

b) Limitations in activity, mass and concentrations, heterogeneities

c) Physical and chemical state, geometric shape, arrangement, irradiation parameters, moisture content, material specifications

d) Special form radioactive material or low dispersible radioactive material,

e) Nature and characteristics of the radiation emitted

f) Limitations in heat generation rate of contents

g) Mass of fissile material and nuclides

h) Other dangerous properties

i) Other limitations to the contents

2.5. Safety relevant limits for non-radioactive materials (e.g. moderators, materials subject to radiolysis) should be stated, for example by material composition, density, form, location within package, restrictions of relative quantities of materials.

2.6. The $A_1/A_2$ values of a radionuclide to be carried that is not listed in IAEA SSR-6 Regulations [1] should be determined in accordance with IAEA paras 403 – 407 and included in the PDSR and may be subject to multilateral approval (see [1], para. 403).

SPECIFICATION OF PACKAGING

2.7. The packaging design should be defined including the following information, as applicable (see annexes):

(a) A list of all packaging components important for safety and complete design drawings

(b) A parts list of all standard items such as bolts, seals, etc

(c) A list of the material specifications of all packaging components important for safety and standard items and methods of their manufacture including requirements for material procurement, welding, other special processes, non-destructive evaluation and testing. All material specifications for packaging components should be included in the PDSR.

A description of:

(d) The packaging body, lid (closure mechanism) and inserts

(e) The packaging components of the containment system

(f) The packaging components required for shielding

(g) The package components of the confinement system

(h) The packaging components for thermal protection

(i) The packaging components for heat dissipation

(j) The protection against corrosion

(k) The protection against contamination

(l) The shock limiting components

(m) The transport concept including any devices required for the transport, safe handling, stowage, trans-shipment and securing in or on the conveyance which has an effect on the safety of the package.

PACKAGE PERFORMANCE CHARACTERISTICS

2.8. This section should describe the main design principles and performance characteristics of the package design to meet the different safety requirements of the regulations (e.g. containment, heat removal, dose rates, and criticality safety). Furthermore it should describe how analysis assumptions and data used for the safety analysis – especially regarding release of radioactive material, dose rates and criticality safety (if applicable) - are derived from the design and the behaviour of the package under routine, normal and accident conditions of transport, also taking into account the intended number of transport cycles for one packaging.

2.9. This should help to ensure that the design and the various parts of the safety demonstration are compatible with one another and that any subsequent decisions taken concerning changes to the package design due to manufacturing, repair, improved operation, etc. include appropriate consideration of the possible influence on the package performance criteria and regulatory compliance.

## COMPLIANCE WITH REGULATORY REQUIREMENTS

2.10. The PDSR should include a complete list of all paragraphs of the international regulations [1], [2] and other international or national regulations applicable to the respective package design. Demonstration of compliance with these paragraphs should be by reference to where in the PDSR compliance is demonstrated or other justification. Table 1 provides references for paragraphs of the IAEA regulations for each package type.

## OPERATION

2.11. The minimum requirements for the following activities should be fully defined for the packaging/package, as applicable (see annexes):

(a) Testing requirements and controls before first use

(b) Testing requirements and controls before each transport

(c) Handling and tie down requirements

(d) Requirements for loading and unloading of the package contents (including torque value requirements for lids)

(e) Requirements for assembling of the packaging components

(f) Any proposed supplementary equipment and operational controls to be applied during transport which are necessary to ensure the package meets the regulatory requirements for transport, e.g. for heat dissipation: thermal barriers, duration limits, temperature limits (including exclusive use and special stowage conditions)

(g) Emergency arrangements that have to be stated in approval certificate as deemed necessary by competent authority, in accordance with GSR Part 7, GSG-2.1, GSG-2 and TS-G-1.2.

## MAINTENANCE

2.12. The minimum requirements for the following activities should be fully defined for the packaging/package, as applicable (see annexes):

(a) Maintenance and inspection requirements before each shipment

(b) Maintenance and inspection requirements at periodic intervals throughout the lifetime use of the packaging/package.

## MANAGEMENT SYSTEMS

2.13. Specification of the management system [5] including the quality assurance programme as requested in the IAEA SSR-6 Regulations [1] to ensure compliance with the relevant provisions regarding (including change control):

(a) Design, PDSR, documentation, records

(b) Manufacture and testing,

Also the requirements relating to the following

(c) Operation (loading, transport, unloading, storage in transit)

(d) Maintenance and repair

(e) Compliance of any activity to the PDSR.

## PACKAGE ILLUSTRATION

2.14. A reproducible illustration, not larger than 21cm by 30cm, showing the make-up of the package, including shock limiters, devices for thermal insulation and packaging inserts, if applicable; the illustration should indicate at least the overall outside dimensions, the masses of the main components of the packaging and the gross masses for empty and loaded condition.

# SECTION III

# PACKAGE DESIGN SAFETY REPORT: PART 2

3.1. Part 2 of the PDSR should provide the detailed technical analyses to support the demonstration of compliance with the regulations in Part 1 of the PDSR, as referred to in paragraph 2.10.

3.2. Paragraph 2.11 of this guide provides the common provisions which should be applied to all technical analyses to be included into Part 2 of the PDSR.

3.3. Paragraph 2.12 of the guide gives a list of the technical analyses that may be necessary in the PDSR together with their main contents. Further guidance on the content of the technical analyses required for each package type is provided in the annexes.

## COMMON PROVISIONS FOR ALL TECHNICAL ANALYSES IN PART 2 OF THE PDSR

3.4. The information in Section 0 should be included in each of the technical analyses in section 0.

### Reference to package design

3.5. In each of the technical analyses of paragraph 2.12, the package design which is evaluated should be precisely referenced by mentioning a design drawing or packaging drawing list (including revision state) and the document specifying the radioactive contents (with revision state), as appropriate.

### Acceptance criteria and design assumptions

3.6. The acceptance criteria for the technical analysis and the package design assumptions in terms of geometry or performance characteristics should be defined and justified when necessary.

### Description and justification of analysis methods

3.7. The safety demonstration of a package design can be accomplished by a combination of the following as appropriate (see annexes):

(a) The results of physical testing of prototypes or models of appropriate scale.

(b) By 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.

(c) By calculation or reasoned argument, when the calculation procedures are generally agreed to be suitable and conservative. Assumptions made may require justification by physical testing.

3.8. The methods/standards used in each analysis listed in sections 3.14 – 3.18 should include a description of the analysis technique used, its limitations and accuracy, together with the justification for how it has been used for the analysis of the package design.
3.9. If computer codes are used for the safety analysis then additional information will be required in order to justify that the code is verified/validated in its field of use. Justification for the applicability of these codes should include a statement of possible sources of errors and/or uncertainties relative to the effects of the operating platform (computer) used and of modelling assumptions and simplifications as well as any other parameter influencing the calculated results.

**Analysis of package design**

3.10. The performance characteristics of the package design should be assessed, as appropriate (see annexes), with an appropriate and identified sensitivity analysis and levels of accuracy stated.
3.11. It is conceivable that more than one accident and consequential damage scenario will 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.
3.12. Other risks which may have a consequential effect on the safety functions should be analysed. This may concern corrosion, combustion, pyrophoricity or other chemical reactions, radiolysis, phase changes, etc

**Comparison between acceptance criteria and results of analysis**

3.13. The results of the analyses detailed in section 3.10-3.12 should be compared with the acceptance criteria and package design assumptions (section 3.6) and regulatory compliance should be justified accordingly.

TECHNICAL ANALYSES

**Structural analysis**

3.14. Assessment of the mechanical behaviour (including fatigue analysis, brittle fracture, creep… if applicable) under routine, normal and accident conditions of transport, as applicable for the type of package, for

(a) The package components of the containment system

(b) The package components that provide radiation shielding

(c) The package components of the confinement system

(d) The package components for which their performance will have a consequential effect upon (a), (b) and (c)

(e) The packaging attachments used for lifting the packaging/package (routine and normal conditions only)

(f) The packaging attachments used for restraining the package/packaging to its conveyance during transport (routine and normal conditions only).

**Thermal analysis**

3.15. Assessment of thermal behaviour for routine, normal and accident conditions of transport including an evaluation of thermal stresses, surface temperatures and the thermal behaviour of, as applicable for the type of package:

(a) The components of the containment system

(b) The components of shielding

(c) The components of the confinement system

(d) The package components for which their performance will have a consequential effect upon (a), (b) and (c).

**Containment design analysis**

3.16. Assessment regarding the requirements for preventing the loss or dispersal, or for limiting the release, of radioactive material under routine, normal and accident conditions of transport, as applicable.

**External dose rates analysis**

3.17. The assessment of the dose rates and dose rate increase ratio for routine, normal and accident conditions as applicable. The analysis should assume a maximum radioactive content or a content that would create the maximum dose rates at the surface of the package and at distances defined in the regulations.

**Criticality safety analysis**

3.18. For packages designed to transport fissile material not excepted from the requirements for packages containing fissile material, assessment of criticality safety for routine, normal and accident conditions of transport, for the isolated package and for the arrays of packages.

# SECTION IV

# DEFINITIONS AND ABBREVIATIONS

## DEFINITIONS

4.1. The definitions stated in the IAEA SSR-6 Regulations [1] apply throughout this publication. In addition the following definitions should apply:

**Package designer**

4.2. The person or organisation that is responsible for the design of the package; each package design should have only one package designer.

**Controlled document**

4.3. A document that is approved and maintained. It should be signed and dated and bear a reference including the revision state. The number of pages and annexes should be mentioned. Changes between revisions of the document should be clearly marked.

**Design drawing**

4.4. A controlled engineering drawing that states for the packaging components the geometrical or other parameters that have an effect upon the safety assessment of the package design.

## ABREVIATIONS

4.5. All abbreviations and acronyms used in this guide come from SSR-6 [1]

## APPENDIX I.

## EXEPTED PACKAGES

Specific additional guidance to provide the information as requested in Part 1 and 2 of the PDSR. In addition further guidance is also available from SSG-26.
For packages containing fissile (not excepted) material see in addition ANNEX 5.
For packages containing more than 0.1 kg uranium hexafluoride see in addition ANNEX 6.
The numbers in the first column of the table refer to paragraph numbers in this guide.

| **Part 1** | |
|---|---|
| 2.2 | To be complied with |
| 2.3 | To be complied with<br><br>(c) The kind(s) of excepted package as assigned by UN numbers should be specified:<br><br>• Empty Packaging (UN 2908), or<br>• Articles Manufactured From Natural Uranium or Depleted Uranium or Natural Thorium (UN 2909), or<br>• Limited Quantity of Material (UN 2910), or<br>• Instruments or Articles (UN 2911), or<br>• Uranium hexafluoride, non-fissile, less than 0,1 kg per package (UN 3507).<br><br>(e) Compliance with additional requirements for air transport (see Table 1 of SSR-6) should be considered, if applicable. |
| 2.4<br>2.5<br>2.6 | To be complied with, except (f)<br><br>(b) Compliance with the activity limits for excepted packages according to Table 4 of SSR-6 and paras 423 and 424 (for transport by post) and with para. 427(for empty packagings), if applicable, should be considered.<br><br>(d) A valid special form certificate should be available if special form radioactive material is used.<br><br>(g) Fissile material is allowed only if excepted according to para. 417 of SSR-6.<br><br>(h) Subsidiary risks of the contents should be taken into account which may result in classification and design requirements according to the predominant subsidiary risk (see [2], Chapter 3.3 SP 290). |
| 2.7 | To be complied with , except (g) - (i)<br><br>(e) may be supported by special form material if applicable (see also comment |

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| | under 1.3 (d) above) |
| 2.8<br>2.9 | The main design principles and performance characteristics for the package design to meet the containment and shielding integrity requirements for excepted packages under routine conditions of transport according to paras 607 – 618 of SSR-6, paras 619 - 621 for packages to be transported by air, paras 515, 516 and if applicable paras 423 (a) and (c), 424 (a) and 426 (see also Table 1) should be described. |
| 2.10 | The appropriate paragraphs as indicated in Table 1 for excepted package should be addressed. |
| 2.11 | Appropriate instructions for use of the package should be developed covering all items under 1.7. Compliance to requirements in paras 564 and 607 - 609 of SSR-6 should be justified taking into account the foreseen routine conditions of transport. Routine conditions of transport should be identified: minimum and maximum ambient temperature during transport, minimum ambient pressure, specifications on bolt torquing requirements, number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included if applicable. |
| 2.12 | Appropriate instructions for maintenance of the packaging should be developed covering all items under 1.8. |
| 2.13 | The management system should be appropriate to the complexity of the design of the package to ensure that the package is designed and tested if necessary to demonstrate it meets the regulatory requirements. This should include a reliable document control system.<br><br>The management system should also ensure that the requirements and standards for: manufacture; inspection before first use and subsequent inspections during use (for repeated use of packaging); maintenance; operating (loading, unloading, operating, transporting) are clearly defined in the PDSR. More detailed guidance is available from [5]. |
| 2.14 | To be complied with |

| **Part 2** | |
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| 3.4 | To be complied with to the extent applicable to demonstrate compliance with the design requirements for excepted package. |
| 3.5 | To be complied with for routine conditions of transport only and not for (c)<br><br>(a) may be supported by special form material if applicable<br><br>Structural analysis should be performed to such an extent that it provides evidence that all applicable design requirements according to paras 607 – 618 of SSR-6, 619 - 621 (for air transport), 623 and 636 (for fissile excepted material), if applicable are met. It 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 |

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| | and pressure requirements for air transport. In particular attention should be paid to ensure that any nuts, bolts and other retention devices keep their safety functions during routine conditions of transport even after repeated use. For more guidance see also SSG-26, paras 607.1 - 621.3 |
| 3.6 | To be complied with for routine conditions of transport only and not for (c)<br><br>Thermal analysis should be performed to such an extent that it provides evidence that all applicable design requirements with thermal aspects according to paras 607-621 of SSR-6 are met, in particular paras 613, 614, 616 and 618 - 620 if applicable. For more guidance see also SSG-26, paras 607.1 - 621.3 |
| 3.7<br>3.8<br>3.9 | To be complied with for routine conditions of transport only.<br><br>It should be performed to such an extent that containment integrity for all relevant aspects according to paras 607-618 and 619-621 of SSR-6, if applicable, is demonstrated. Other dangerous properties of contents – see paras 110 and 507. |
| 3.10<br>3.11<br>3.12 | To be complied with for routine conditions of transport only (see paras 508, 509 and 516 of SSR-6).<br><br>Shielding analysis should be performed to such an extent that it provides evidence that all applicable radiation level requirements are met according to paras 516 and 423 (a) of SSR-6, if applicable. If calculation methods are used the calculations of source terms should take into account the interactions, secondary emissions, multiplication factors when relevant. The appropriate ICRP recommendations should be taken into account. If measurements are used the measuring source should be representative for the radioactive contents of the package design. |
| 3.13 | Not applicable: non excepted fissile material is not allowed in excepted packages. |

## APPENDIX II.

## INDUSTRIAL PACKAGES

Specific additional guidance to provide the information as requested in Part 1 and 2 of the PDSR. In addition further guidance is also available from SSG-26.
For packages containing fissile (not excepted) material see in addition ANNEX 5.
For packages containing more than 0.1 kg uranium hexafluoride see in addition ANNEX 6.
The numbers in the first column of the table refer to paragraph numbers in this guide.

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| **Part 1** | |
| 2.2 | To be fully complied with |
| 2.3 | 0 To be complied with<br><br>(c) the type of industrial package should be specified:<br><br>- Industrial package Type 1 (Type IP-1);<br><br>- Industrial package Type 2 (Type IP-2) or<br><br>- Industrial package Type 3 (Type IP-3)<br><br>(e) compliance with additional requirements for air transport (see Table 1 of SSR-6) should be considered |
| 2.4<br>2.5<br>2.6 | To be complied with.<br><br>(b) Limitations in specific activity (Bq/g) and surface contamination ($Bq/cm^2$) may be required.<br><br>Regarding classification of material in SSR-6 the contents should be classified as LSA-I, LSA-II or LSA-III (para. 409) or SCO-I or SCO-II (para. 412). According to this classification of contents the type of Industrial Package should be justified (para. 521 and Table 5 of SSR-6)<br><br>Compliance with the dose rate limit at 3 m from the unshielded contents established in para. 517 should be assessed.<br><br>Conveyance activity limits according to Table 6 of SSR-6 should also be taken into account to limit the activity of a single package, if applicable.<br><br>(c) Limits of contents in industrial package depend of physical state.<br><br>In case of LSA–III, as applicable for Type IP-2 or Type IP-3 according to the Table 5 of SSR-6, compliance with para. 601 should be justified.<br><br>(f) if applicable<br><br>(g) If the package contains fissile excepted materials, compliance to provisions in para. 417 of SSR-6 should be justified; if the package contains non-excepted fissile |

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| | materials, refer to ANNEX 5. |
| 2.7 | To be complied with, except (i)<br><br>1 (g) if applicable, see ANNEX 5<br><br>2 (h) if applicable in connection with ANNEX 5 or ANNEX 6 |
| 2.8<br>2.9 | The main design principles and performance characteristics for the package design should be described to meet the containment and shielding integrity requirements for:<br><br>- Type IP-1 under routine conditions of transport according to paras 606 - 619 and 636 of SSR-6.<br><br>- Type IP-2 under routine and normal conditions of transport according to paras 607 - 621, 624 and 636 of SSR-6 or alternative requirements in paras 624 - 628 for packages, tank containers, tanks (other than tank containers), freight containers and metal intermediate bulk containers.<br><br>- Type IP-3 under routine and normal conditions of transport according to paras 607 - 621, 636 - 649 of SSR-6 or alternative requirements in paras 627 - 630 for tank containers, tanks (other than tank containers), freight containers and metal intermediate bulk containers.<br><br>- Type IP-1, Type IP-2 and Type IP-3 according to paras 526 - 528 of SSR-6<br><br>(see also Table 1) |
| 2.10 | The appropriate paragraphs as indicated in Table 1 of SSR-6 for Type IP-1, Type IP-2 and Type IP-3 package should be addressed |
| 2.11 | Appropriate instructions for use of the package should be developed covering all items under 1.7. Details of the package handling operations may be included in more exhaustive written procedures to which reference may be made in this part of the PDSR.<br><br>(a) In compliance with para. 501(a) of SSR-6, if the design pressure of the containment system exceeds 35 kPa, a procedure for testing the integrity of the containment system under that pressure should be included.<br><br>(b) Testing and control procedures should be included to ensure that:<br><br>• All the requirements specified in the relevant provisions of SSR-6 applicable to Industrial Packages have been satisfied, according to para. 503 of SSR-6.<br><br>• Lifting attachments which do not meet the requirements of para. 608 of SSR-6 have been removed or otherwise rendered incapable of being used for lifting the package, according to para. 503 (a) of SSR-6. |

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| | (c) Specifications on bolt torquing requirements, number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included if applicable.<br><br>In addition to the radioactive properties, any other dangerous properties of the contents of the package should be taken into account. (see para. 507) |
| 2.12 | Appropriate instructions for maintenance of the package should be developed covering all items under 1.8. |
| 2.13 | The management system should be appropriate to the complexity of the design of the package to ensure that the package is designed and tested if necessary to demonstrate it meets the regulatory requirements. This should include a reliable document control system.<br><br>The management system should also ensure that the requirements and standards for manufacture; inspection before first use and subsequent inspections during use (for repeated use of packaging); maintenance; operating (loading, unloading, operating, transporting) are clearly defined in the PDSR. More detailed guidance is available from [5]. |
| 2.14 | To be complied with |
| **Part 2** | |
| 3.4 | To be complied with to the extent applicable to demonstrate compliance with the regulatory requirements for Type IP-1, IP-2 and IP-3 packages |
| 3.14 | Structural analysis should be performed to such an extent that it provides evidence that:<br><br>(I) Type IP-1 package complies with requirements defined for routine conditions of transport according to paras 607-621 of SSR-6; in particular, this analysis should consider:<br><br>• Attachments used for restraining the package (para. 607 of SSR-6)<br><br>• Attachments used for lifting the package (paras 608 and 609 of SSR-6)<br><br>• Features added to the package during transport (para. 612 of SSR-6)<br><br>• Behaviour of package and their components with respect to the effects of any acceleration, vibration or vibration resonance (para. 613 of SSR-6)<br><br>• Behaviour of package with respect to ambient temperatures and pressures that are likely to be encountered in routine conditions (para. 616 of SSR-6)<br><br>(II) Type IP-2 package complies with requirements defined for routine conditions and normal conditions of transport according to paras 607 - 621 |

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| | and 624 of SSR-6 or alternative requirements in paras 626 - 630; in particular this analysis should consider the same points showed for Type IP-1 package above and in addition the assessment of compliance with the acceptance criteria defined in para. 624 for the mechanical tests specified in paras 722 and 723 of SSR-6.<br><br>(III) Type IP-3 package complies with requirements defined for routine conditions and normal conditions of transport according to paras 607 - 621, 636 - 649 or alternative requirements in paras 627 – 630 of SSR-6; in particular this analysis should consider the same points showed for Type IP-1 package above and in addition:<br><br>• The assessment of compliance with the acceptance criteria defined in para. 648 for the mechanical tests specified in paras 721 - 724 of SSR-6.<br><br>• An analysis of the tie-down attachments on the package, if applicable (para. 638)<br><br>9. If the testing assessment is conducted by real tests the test report should address that:<br><br>• drop tests are carried out according to a quality assurance program<br><br>• specimen, prototype or sample is representative of the package<br><br>• Drop tests are performed so as to cause the worst damage. The demonstration that the drop test orientation causes the worst damage to the tested function (containment or shielding) should be established according to a quality assurance program.<br><br>• The target for drop tests complies with applicable prescriptions.<br><br>This test report should also contain pictures showing and explaining the performing conditions of the tests and their results.<br><br>For more guidance see also the corresponding paragraphs of SSG-26. |
| 3.15 | Thermal analysis should be performed in such a way that it provides evidence that all applicable design requirements with thermal aspects are met, in particular for:<br><br>- Type IP-1 and Type IP-2 packages:<br><br>• Behaviour with respect to the ambient temperatures to be encountered in routine conditions (para. 616 of SSR-6).<br><br>• Analysis of temperatures on accessible surfaces of the package, in cases of air transport (para. 619 of SSR-6).<br><br>• Behaviour with respect to ambient temperatures ranging from –40°C |

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| | to +55°C, in case of air transport (para. 620 of SSR-6).<br><br>Type IP-3 package: the same points shown for Type IP-1 and Type IP-2 packages above and, in addition, an assessment of the behaviour with respect to temperatures ranging from –40°C to +70°C range (paras 639 and 649 of SSR-6).<br><br>(a) Attention should be paid to ensure that sealing joints retain their safety functions for the temperature ranges indicated above.<br><br>For more guidance see also the corresponding paragraphs of SSG-26 |
| 3.16 | Containment analysis should be performed in such a way that it provides evidence that all applicable requirements applicable to the containment system are met, in particular for:<br><br>- Type IP-1:<br><br>• Protection of valves through which the contents could otherwise escape, if applicable (para. 615 of SSR-6).<br><br>• Behaviour of package with respect to reduction of ambient pressures in air transport (para. 621 of SSR-6).<br><br>- Type IP-2 packages: the same points shown for Type IP-1 and, in addition: prevention of loss or dispersal of the radioactive contents (paras 624(a), 626(c)(i), 629(c)(i), 630 (b)(i) of SSR-6 as applicable)<br><br>- Type IP-3 package, the same points shown for Type IP-1 and Type IP-2 packages above and, in addition:<br><br>• Fastening device of the containment system (paras 641 and 643 of SSR-6).<br><br>• An analysis that internal pressure in package, if applicable, will not impair the fastening device of the containment system (para. 641 of SSR-6).<br><br>• Behaviour of the containment system with respect to the radiolysis caused by the contents, if applicable (par.644 of SSR-6).<br><br>• Behaviour of containment system with respect to a reduction of ambient pressure to 60 kPa (para. 645 of SSR-6).<br><br>• Leakage retention systems in valves, other than pressure relief, if applicable (para. 646 of SSR-6).<br><br>• Design of shielding enclosing components of the containment system (para. 647 of SSR-6).<br><br>The assessment of the containment system under all operating conditions should be accomplished considering the most limiting package contents from the chemical and |

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| | physical point of view and taking into account the maximum internal pressures.<br><br>10. Where appropriate, an analysis and justification of the tightening torques to be used to maintain containment under routine and normal conditions should be performed, as applicable.<br><br>11. A description of the leak tests required to demonstrate that the package fulfils the containment requirements, such as tests performed during and following the manufacturing of the packaging, periodic testing and tests prior to each transport operation should be included.<br><br>For more guidance see also the corresponding paragraphs of SSG-26 |
| 3.17 | The analysis of aspects relating to the shielding system of the packaging should assure that the dose rate limits established by the regulations will be met, in particular for:<br><br>- Type IP-1 packages, the dose rate limits for routine conditions of transport (paras 526-528 of SSR-6).<br><br>- Type IP-2 packages, in addition to the limits for routine conditions, when the packages were subjected to the specified tests it would prevent more than a 20% increase in the maximum radiation level at any external surface of the package according to paras 624(b), 626(c)(ii), 627(c), 628(c), 629(c)(ii) and 630(b)(ii) of SSR-6 as applicable.<br><br>- Type IP-3 packages, in addition to the limits for routine conditions, when the packages were subjected to the specified tests it would prevent more than a 20% increase in the maximum radiation level at the external surface of the package, according to paras 627(c), 628(c), 629(c)(ii), 630(b)(ii) and 648(b) of SSR-6 as applicable.<br><br>For Type IP-2 and Type IP-3 packages attention should be given to define precisely the retention system inside the package if applicable (example: transport of contaminated tools) in order to prevent any displacement of the contents that would lead to more than 20% increase in the maximum radiation level.<br><br>If calculation methods are used, the calculations of source terms should take into account the interactions, secondary emissions, multiplication factors when relevant. If measurements are used the measuring source should be representative for the radioactive contents of the package design.<br><br>For more guidance see also the corresponding paragraphs of SSG-26 |
| 3.18 | If applicable, see also ANNEX 5 |

## APPENDIX III.

## TYPE A PACKAGES

Specific additional guidance to provide the information as requested in
Part 1 and 2 of the PDSR. In addition further guidance is also available from SSG-26.
For packages containing fissile (not excepted) material see in addition ANNEX 5.
For packages containing more than 0.1 kg uranium hexafluoride see in addition ANNEX 6.
The numbers in the first column of the table refer to paragraph numbers in this guide.

| **Part 1** | |
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| 2.2 | To be complied with |
| 2.3 | To be complied with<br><br>(e) compliance with additional requirements for air transport (see Table 1 of SSR-6) should be considered |
| 2.4<br>2.5<br>2.6 | To be complied with.<br><br>(b) Compliance with the activity limits for Type A packages according to paras 429 – 430 of SSR-6 should be considered.<br><br>(c) there are additional design requirements for liquids and gases contents<br><br>(d) a valid special form certificate should be available if special form radioactive material is used<br><br>(f) if applicable<br><br>(g) If the package contains fissile excepted material, compliance to provisions in para. 417 of SSR-6 should be justified; if the package contains non-excepted fissile material, refer to ANNEX 5. |
| 2.7 | To be complied with, except (i)<br><br>(e) may be supported by special form material if applicable (see also comment under 1.3 (d) above)<br><br>(g) if applicable, see ANNEX 5<br><br>3 (h) if applicable in connection with ANNEX 5 or 6 |
| 2.8<br>2.9 | The main design principles and performance characteristics for the package design should be described to meet the containment and shielding integrity requirements for Type A packages under routine and normal conditions of transport according to paras 607 - 621, 636 - 648 and 526 - 528 of SSR-6. See also paras 649 - 651 for liquids and gases contents. (see also Table 1) |
| 2.10 | The appropriate paragraphs as indicated in Table 1 for Type A package should be |

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| | addressed. |
| 2.11 | Appropriate instructions for use of the package should be developed covering all items under 1.7. In particular also specifications on bolt torquing requirements, number of transport cycles (to be used in fatigue analysis) for each mode of transport should be included if applicable.<br><br>In addition to the radioactive properties, any other dangerous properties of the contents of the package should be taken into account (see para. 507 of SSR-6).<br><br>(e) including compliance with para. 637 of SSR-6. |
| 2.12 | Appropriate instructions for maintenance of the package should be developed covering all items under 1.8. |
| 2.13 | The management system should be appropriate to the complexity of the design of the package to ensure that the package is designed and tested if necessary to demonstrate it meets the regulatory requirements. This should include a robust document control system.<br><br>The management system should also ensure that the requirements and standards for manufacture; inspection before first use and subsequent inspections during use (for repeated use of packaging); maintenance; operating (loading, unloading, operating, transporting) are clearly defined in the PDSR. More detailed guidance is available from [5]. |
| 2.14 | To be complied with |
| **Part 2** | |
| 3.4 | To be complied with to the extent applicable to demonstrate compliance with the regulatory requirements for Type A packages. |
| 3.6 | All characteristics (mechanical, thermal…) of each component of the package and acceptance criteria for technical analyses should be defined.<br><br>Examples<br><br>Compliance with para. 639 of SSR-6 should include criteria for some of the items as:<br><br>- expansion/contraction of components relative to the structural or sealing functions;<br>- decomposition or changes of state of component materials at extreme conditions;<br>- tensile/ductile properties and package strength;<br>- shielding design. |

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| 3.10<br>3.11<br>3.12 | For structural analysis, compliance with the para. 648(a) of SSR-6 should include a criterion to ensure that under normal transport conditions the radioactive contents of the package cannot escape in quantities that may create a radiological or contamination hazard. (See also SSG-26 paras 648.1 - 648.6)<br><br>The conformity of the drop tests with the requirements should be demonstrated and an exhaustive description of the drop tests should be documented. The following should also be addressed :<br><br>- Drop tests are accomplished according to a quality assurance program.<br><br>- Specimen, prototype or sample is representative of the package.<br><br>- Drop tests are performed so as to cause the worst damage. The demonstration that the drop test orientation causes the worst damage to the tested function (containment, shielding or criticality safety) should be established according to a quality assurance program<br><br>- The target for drop tests complies with applicable prescriptions. It should be flat and unyielding (a steel plate of sufficient thickness floated on to a concrete block), massive enough to resist to any displacement.<br><br>- A drop test report is established according to a quality assurance program, addressing the verification of the package before testing, the description of the test site, the measurement equipments used and their calibration, the results of performed measures ensuring that pre-established criterions are met. This report should also contain pictures showing and explaining the performing conditions of the tests and their results.<br><br>Subsidiary risks should be addressed in the demonstrations of compliance. |
| 3.14 | To be complied with for routine and normal conditions of transport and not for (c)<br><br>(a) may be supported by special form material if applicable (para. 642 of SSR-6).<br><br>Structural analysis should be performed to such an extent that it provides evidence that all applicable design requirements according to paras 607 - 621, paras 636 - 648 and if applicable paras 649 – 651 of SSR-6 are met.<br><br>Attention should be paid to ensure that any nuts, bolts and other retention devices remain their safety functions during routine conditions of transport even after repeated use.<br><br>It should take into account temperatures and pressures according to paras 639 and 645 of SSR-6.<br><br>For more guidance see also SSG-26, paras 607.1 - 621.3 and paras 636.1 - 651.3.<br><br>Tests procedures take into account requirements of paras 701 - 702, 713 - 715, 716 and 719 - 724 of SSR-6 (see also 725 for additional tests for Type A packages |

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| | designed for liquids and gases). |
| 3.15 | To be complied with for routine and normal conditions of transport and not for (c)<br><br>Thermal analysis should be performed to such an extent that it provides evidence that all applicable design requirements with thermal aspects according to paras 607 - 621 and paras 636-651 of SSR-6 are met, in particular paras 613, 614, 616, 639, 648 and 618-619, 642, 644 if applicable.<br><br>For more guidance see also SSG-26, paras 607.1 - 621.3 and 636.1 - 651.3. |
| 3.16 | To be complied with for routine and normal conditions of transport.<br><br>It should be performed to such an extent that containment integrity for all relevant aspects according to paras 607 - 621 and 636 - 651 of SSR-6 can be demonstrated (in particular paras 641 - 645).<br><br>Attention should be paid to define precisely the contents. Assumptions and demonstrations are different according to the contents.<br><br>Attention should be paid to demonstrate the ability to withstand reduced ambient pressure due to altitude encountered during transportation (para. 645 and para. 621 if applicable).<br><br>Where special form radioactive material constitutes part of the containment system, consideration should be given to the appropriate performance of the special form material under the routine and normal conditions of transport. |
| 3.17 | To be complied with for routine and normal conditions of transport.<br><br>See para. 647 and SSG-26, paras 647.1 - 647.2.<br><br>If calculation methods are used the calculations of source terms should take into account the interactions, secondary emissions, multiplication factors when relevant. The appropriate ICRP recommendations should be taken into account. If measurements are used the measuring source should be representative for the radioactive contents of the package design.<br><br>Routine conditions of transport<br><br>Shielding analysis should be performed to such an extent that it provides evidence that all applicable radiation level requirements are met according to paras 527 – 528 of SSR-6.<br><br>Normal conditions of transport<br><br>If the package were subjected to the tests specified in paras 719 – 724 of SSR-6, it would prevent more than a 20% increase in the maximum radiation level at the external surface of the package according to para. 648.<br><br>Attention should be given to define precisely the tie-down system inside the |

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| | package if applicable (example: transport of contaminated tools) in order to prevent any displacement of the contents that would lead to more than 20% increase in the maximum radiation level. |
| 3.18 | If applicable, see also ANNEX 5 |

## APPENDIX IV.

## TYPE B(U), TYPE B(M) AND TYPE C PACKAGES

Specific additional guidance to provide the information as requested in Part 1 and 2 of the PDSR.
In addition further guidance is also available from SSG-26.
For packages containing fissile (not excepted) material see in addition ANNEX 5.
For packages containing more than 0.1 kg uranium hexafluoride see in addition ANNEX 6.
The numbers in the first column of the table refer to paragraph numbers in this guide.

| **Part 1** | |
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| 2.2 | To be complied with |
| 2.3 | To be complied with |
| 2.4<br>2.5<br>2.6 | To be complied with – including 1.3(g) when contents are fissile or fissile excepted.<br><br>(d) A valid special form certificate should be available if special form radioactive material is used; a valid low dispersible radioactive material certificate should be available if low dispersible radioactive material is used<br><br>(g) If the package contains fissile excepted materials, compliance to provisions in para. 417 of SSR-6 should be justified; if the package contains non- excepted fissile materials, refer to ANNEX 5.<br><br>The description of the contents and of their physical, chemical and radioactive forms should be sufficiently precise to allow the demonstration of compliance with the requirements for containment, radiation protection, the criticality-safety and protection against heat.<br><br>The description should include all dimensions (drawings), material grades and mechanical properties which are used in demonstrating the required safety performances.<br><br>The description should include<br><br>• the total numbers of $A_2$ or $A_1$ in the contents<br>• if applicable, the maximum burn-up and minimum cooling time;<br>• the composition and the weight of hydrogenated materials that may interact with the contents (for neutron multiplication or radiolysis)<br><br>The properties of materials should be given for temperatures ranging from -40°C to the maximum temperature in normal conditions of transport. |
| 2.7 | To be complied with<br><br>(e) may be supported by special form material if applicable (see also comment |

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| | under 1.3 (d) above)<br><br>(g) if applicable, see ANNEX 5 |
| 2.8<br>2.9 | To be complied with |
| 2.10 | The appropriate paragraphs as indicated in Table 1 for Type B(U), Type B(M) or Type C package should be addressed. |
| 2.11 | To be complied with<br><br>Detailed description of the methods used for operational controls and tests, in particular those required in paras 501 (a), 502, 503, 508, 523, 527 and 528 of SSR-6. For drying operations, method used should prevent formation of ice. For leaktightness testing, when the competent authority accepts methods using slackened criteria, qualified methods for detection of defects (that might create in operating conditions a leakage with a rate higher than permissible) should be implemented (see 2.2.3). The absence of defects should be ensured by a specific inspection procedure with appropriate qualification. 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. |
| 2.12 | To be complied with<br><br>• Detailed description of the maintenance activities, in particular:<br><br>• Periodic controls of the components of the containment system (screws, bolts, welds, O-rings…)<br><br>• Periodic controls of the tie-down and handling attachments…<br><br>• The definition of the periodicity of replacement of the packaging components should take into account any reduction in efficiency due to wear, corrosion, ageing and change in seal compression with time etc.<br><br>The justification of the periodicity of controls, when needed, may take place in this section. |
| 2.13 | To be complied with (see para. 306 of SSR-6). The management system should be appropriate to the complexity of the design of the package to ensure that the package is designed and tested if necessary to demonstrate it meets the regulatory requirements. This should include a robust document control system.<br><br>The management system should also ensure that the requirements and standards for: manufacture; inspection before first use and subsequent inspections during use (for repeated use of packaging); maintenance; operating (loading, unloading, operating, transporting) are clearly defined in the PDSR. This includes:<br><br>• The PDSR should describe the principles and requirements of Quality Management Systems which have been and will be applied to all the activities involved in the transport of radioactive and/or fissile materials in the package |

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| | being assessed (design including design modification, qualification, safety studies, manufacture, commissioning, preparation for transport, loading, transport, transit, unloading, maintenance).<br><br>• The PDSR should define and classify all significant components for safety with, for each the associated functions of safety, the parameters to be guaranteed for the maintenance of these functions and the level of controls to be performed during manufacturing.<br><br>• The PDSR should justify qualification of the computer codes used for verification.<br><br>More detailed guidance is available from [5] |
| 2.14 | To be complied with |
| **Part 2** | |
| 3.4 | To be complied with |
| 3.7<br>3.8<br>3.9 | (a) When a campaign of tests is implemented for a specific design to be approved by competent authorities, the campaign should be notified to the competent authorities in advance of the testing programme and the competent authority should be allowed to witness testing. When such compaing of tests is done without competent authority approval, but are part of the safety analysis, its validity is to be determined by the competent authority. |
| 3.10<br>3.11<br>3.12 | For the assessment of effects concerning radiolysis and/or thermolysis on the performance characteristics of the package design (internal pressure elevation, internal inflammation or explosion) the following should be considered:<br><br>• In all cases where water or hydrocarbonated materials is/are present (cellulose, polymers, aqueous or organic solutions, absorbed humidity), proof of the absence of the risk of accumulation of combustible gases exceeding the limiting concentration for inflammability should be included.<br><br>• Use of calculation codes in order to justify the absence of radiolysis hazards in a package is acceptable if these codes are qualified, through experimental measurements, incorporating the chemical composition of the environment considered and such physical parameters as temperature, pressure, filling gas, etc. Otherwise, a gradual and cautious approach should be selected, considering an experimental check at reduced activity level of the contents and performed, for instance, during first transports in order to reset the codes used.<br><br>• When the radiolysis phenomenon limits the maximum duration of transport, this duration should necessarily integrate duration for incident and emergency response operations.<br><br>• In the event of loading of leaking fuel rods, contained water should be taken into account, except justification |

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| | In addition, if applicable, the risks of chemical or physical reactions for materials which react with water or oxygen, for example, sodium, UF6, plutonium and metallic uranium, etc, or which can suffer a change of phase (freezing, melting, boiling, etc) should be considered. |
| 3.14 | 4 To be complied with<br><br>(i) General remarks<br><br>1. Demonstration of the compliance with the performance standards (SSR-6) should be accomplished by methods listed in SSR-6 para. 701.<br><br>2. The mechanical properties of the materials considered in the safety demonstration should be representative for the range of mechanical properties of the package components considering e.g. the applicable temperature ranges between -40°C and +70°C (see para. 639) and the temperature range of the respective package components in normal conditions of transport (see para. 653 of SSR-6).<br><br>3. For instance the following points should be considered:<br><br>• The impacts on the package behaviour due to variations in the shock absorbing properties of the shock absorber material (wood, polymers, plaster, concrete etc.) with temperature range from -40°C to the maximum temperature in normal conditions of transport, or moisture should be analysed.<br><br>• The safety against brittle fracture at -40°C of components of the containment system made of potentially brittle materials (e.g. ferritic steels, cast iron) should be analysed.<br><br>• Strength of lid bolts should be justified for all drop orientations.<br><br>• Preferably avoid any excursion in the plastic domain for containment system components such as bolts, gasket seats etc. (which would require additional complex proofs concerning the mechanics of the rupture or the maintenance of sufficient gasket seating …).<br><br>• Possible damage of metallic seals after drops due to vibrations or sliding of the lid should be evaluated.<br><br>• Verification that internal components are not liable to damage the containment system.<br><br>• The condition of the containment system should be determined to enable the requirements of 2.2.3 to be demonstrated within the temperature range |

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| | concerned (-40°C, maximum temperature in accident conditions of transport).<br><br>• Retention, after the mechanical tests for accident conditions of transport, of sufficient thermal protection to guarantee the containment or other components safety function.<br><br>• Verification of the mechanical behaviour of the content and the basket<br><br>• The effect of the thermal test on the mechanical behaviour of the package components are to be considered (e.g. thermal stresses and strains, thermo-mechanical interactions between package components).<br><br>• Proof of the ability to withstand the maximum pressure in normal conditions of transport and accident conditions of transport (taking into account fire and radiolysis (internal pressure elevation, internal inflammation or explosion), physical changes, chemical reactions etc.).<br><br>• Considering the appropriate water immersion test depending on the content activity of the package.<br><br>• Concerning packages transported with a cavity containing water, the PDSR should include the demonstration that the water presence does not impair the validity of the containment system tightness inspection by sealing the leakage paths.<br><br>• Analysis of the influence of any devices described in 1.4 (m) on the performances of the package in accident conditions of transport if necessary.<br><br>(ii) Experimental drop testing<br><br>1. Determination of the most severe drop test positions and sequences under consideration of the protection objectives (containment, criticality safety, shielding).<br><br>2. 9 m drop tests (horizontal, slap down, vertical, oblique.) and 1 m puncture tests which maximise loading of the package (such as stress, strain, acceleration and deformation) with consideration of the different package components (cask body, lid system, impact limiter, etc.). The drop test positions are to be selected in such a way that critical load conditions of the individual package components are met.<br>For instance the following aspects should be considered:<br><br>• Drop tests which maximise the stresses and acceleration (flat, slap down …): The greater the impact area is, the harder is the impact (constant stiffness per unit area assumed).<br><br>• Drop test which maximise the deformation (on corner, on edges …): in contrast, the smaller the impact area is, the greater is the crushing. |

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| | • Drop tests which maximise the damages 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.<br><br>• Drop tests which maximise the risk of perforation by a puncture bar, possibly oblique: if the 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 are much higher.<br><br>3. For reduced scale models similar or conservative geometry and material properties are to be used as with the original design.<br><br>4. It is to be guaranteed that the results of the drop test with reduced scale models are covering and/or transferable to the original design.<br><br>5. Representativeness of drop tests performed with reduced scale models:<br><br>• Drop heights: when the demonstrations of the mechanical resistance of a package are based on tests with reduced scale models, it may be necessary to increase the drop heights to simulate the total potential energy that would have been received by the package at full scale. This is especially to be considered for drop tests where the characteristic deformation of the structure is not negligible in comparison to the drop height.<br><br>6. Appropriate geometry scaling of all components of the containment system (lids, nuts and bolts, grooves for the seals etc.).<br><br>• Metallic gaskets: same design, same material and homothetic transformation with regard to elastic restitution.<br><br>• O-rings: the similarity should be based on the useful elastic restitution taking into account the compression set. The change of material properties according to temperature conditions should be considered.<br><br>• The scaling of tightening torques for bolts of the reduced scale model should take into account the dispersion of friction conditions, precision of torques and technical limitations in an exact geometrical and physical scaling of the containment system components.<br><br>• Similar welding seams.<br><br>• In case of reduced scale model drop testing with significant deformations of impact limiters, the original package performance should be carefully justified.<br><br>(iii) Calculation<br><br>1. See point 1. and 2. under (ii).<br><br>2. Calculations are to be used only with verified and validated computation models. It should be proven that input parameters (material laws, characteristic |

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| | values, boundary conditions etc.) describe sufficiently and precise the real technical/physical problems.<br><br>3. If uncertainties exist regarding important input parameters (e.g. material laws) conservative design calculations including the possible range of material properties should be performed in order to assess limiting values within the target magnitudes of technical problems (e.g. stresses, deformations, temperatures).<br><br>4. All data used (material laws, boundary conditions, load assumptions etc.) and calculation results are to be documented in detail and comprehensibly. |
| 3.15 | To be complied with<br><br>• Consideration of the effects of insolation on a period of 12 hours according to para. 657 of SSR-6. Averaging on 24 hours should not be accepted.<br><br>• Consideration of the presence of protective systems liable to oppose heat dissipation in normal conditions of transport: tarpaulins, canopies, additional screens, outer packaging (containers, boxes, etc), if applicable.<br><br>• Justification of simplifying assumptions used for calculation in normal and accident conditions of transport (for example: absence of trunnions).<br><br>• Packaging in accident conditions of transport should be analyzed in the position more penalizing (horizontal or vertical).<br><br>• The solar insolation before and after the fire test should be taken into account as defined in SSR-6 para. 728.<br><br>• The absorptivity coefficient of the external surface of the package should not be lower than 0.8, without additional justification (see para. 728(a) of SSR-6), during and after the fire test to account for deposits upon package surface. The absorptivity coefficient should also not be lower than the possible maximum value of the emissivity coefficient in routine conditions of transport.<br><br>• The evaluation of the minimum/maximum temperatures of the various components of the packaging should take account of all the possible positions for the radioactive contents.<br><br>• The profile of heat power according to burn up distribution in irradiated fuels should be taken into account in the thermal analyses.<br><br>• When thermal analysis is based on test results, it should be justified that the temperature measurements were performed at thermal equilibrium. |

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| | • When the thermal test is made in a furnace and that it is noted that some package components burn, the concentration of oxygen present in the furnace should be controlled and in conformity with that obtained in a hydrocarbon fuel-air fire. In addition, control of heat input should be considered thoroughly.<br><br>• The influence of combustible materials which generate additional heat input and affect the fire duration should be taken into account for safety analyses.<br><br>• The safety margins on temperature results derived using numerical modelling should be commensurate with the uncertainty associated to the numerical model.<br><br>• Analysis of the influence of the devices specified in 1.4 (m) in fire conditions on the performances of the package, if applicable.<br><br>• Demonstration that the spare volume in the gasket grooves allows for gasket thermal expansion in normal and accident transport conditions, unless appropriate justification is provided. |
| 3.16 | To be complied with<br><br>The technical assessment should demonstrate compliance with the release criteria in normal and accident conditions of transport. Consideration of all the possible releases, in the form of gases, liquids, solids or aerosols, through leaks or by permeation should be included.<br><br>• Accident conditions of transport: Mechanical resistance of the irradiated fuel assemblies with respect to the internal pressure should be assessed. 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 rod for the temperature conditions in normal conditions of transport and for the burn up of the irradiated fuel assemblies, in combination with the free drop test.<br><br>• Analysis of the condition of the irradiated fuel assemblies in accident conditions of transport (risk of cracking or rupture of the fuel rod at their ends) should be included if necessary for safety demonstration.<br><br>• Justification of fission gas release percentage out of fuel material.<br><br>• The presence of debris and of aerosols in the container cavity for irradiated fuels in the case of complete rupture due to the shearing of the rods should be considered.<br><br>• The formation of aerosols for contents consisting of materials in powder form should be considered in accident conditions of transport. |

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| | • The long term behaviour of gasket material should be considered.<br><br>• A reduction of ambient pressure to 60 kPa should be considered for evaluation of activity release. |
| 3.17 | To be complied with.<br><br>• Compliance with dose rate limits under routine, normal and accident conditions of transport should be demonstrated for the maximum radioactive content or a content that would create the maximum dose rates at the surface of the package and at distances defined in the regulations (paras 526-528, 648(b), 659(b)(i) or 671(b) of SSR-6 as appropriate).<br><br>• Dose rate analysis should be performed in such a way that in particular package surface areas with maximum dose rates are identified and analysed like e.g. trunnion areas, areas containing gaps which give rise to "radiation passes" and other areas with the potential of increased dose rates due to design determined, reduced shielding parts (weak points for shielding).<br><br>• Based on dose rates analysis the maximum radioactive contents of the package design should be justified by various methods and parameters like e.g. nuclide specific radioactivity values, nuclide specific source terms for gamma and neutron emitters and others as appropriate.<br><br>• If measurements are applied to demonstrate compliance with the dose rates limits then representative radiation sources should be selected as well as appropriate calibrated dose rate measuring techniques used for gamma and neutron radiation, as applicable.<br><br>• All calculational methods used for dose rate analysis should be qualified and validated for the specific conditions of the package design they are applied to. Dose rate calculations should take account of the current ICRP recommendations.<br><br>• The expected areas for peak dose rates to be checked before shipment should be specified.<br><br>• Proof that the sources are maintained secure in their storage positions in the irradiators (under drop test sequence conditions) should be provided, if applicable.<br><br>• Local fusion of the materials providing radiation protection under fire conditions should be considered, if applicable, taking into account the effects of the bar or demonstration that this fusion is limited to a volume which is compatible with the regulatory dose rate criteria in accident conditions of transport.<br><br>• Justification of the consolidation height of lead (lead slump) after the |

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| | 9 m drop test taking into account the temperature of the lead due to the normal conditions of transport should be provided, if applicable.<br><br>• Evaluation of the risks associated with the segregation phenomena (for example precipitation of salts in solution...).<br><br>• Justification of the absence of loss of protection which would result in an increase of more than 20 % of the maximum dose rate in normal conditions of transport. |
| 3.18 | If applicable, see also ANNEX 5 |

# APPENDIX V.

## ADDITIONAL REQUIREMENTS FOR PACKAGES CONTAINING FISSILE MATERIAL

Specific additional guidance to provide the information as requested in Part 1 and 2 of the PDSR. They apply in addition to those items belonging to the package type defined by the radioactive properties of the contents, see Annexes 2, 3, 4 and 6. Further guidance is also available from SSG-26.

The numbers in the first column of the table refer to paragraph numbers in this guide.

| **Part 1** | |
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| 2.3 | To be complied with.<br><br>1.2(e) – If transported by air, then the air transport testing requirements of SSR-6 para. 683(a) and (b) for a single package should be accounted for. |
| 2.4<br>2.5<br>2.6 | 1.3(c) and (i) – Criticality safety can be very sensitive to the presence and geometrical arrangement of fissile material (e.g. possibility and size of lattice arrangements), moderators (water, graphite, beryllium, and other light elements) and reflectors. This should be taken into account in the description of the contents (permitted and not permitted).<br><br>1.3(g) -to be complied with.<br><br>Also describe quantities of nuclides able to sustain chain reaction whereas not defined as fissile: 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.<br><br>All variants of contents should be defined. |
| 2.7 | 1.4(g) to be complied with |
| 2.8<br>2.9 | To be complied with<br><br>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 condition of the parts of the confinement system under normal and accident conditions should be derived from the design and the behaviour of the package under these test conditions, otherwise conservative assumptions should be taken and their conservatism should be shown.<br><br>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 well |

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| | justified. |
| 2.10 | To be complied with<br><br>The appropriate paragraphs as indicated in Table 1 for packages containing fissile material should be addressed. |
| 2.11 | To be complied with, especially (b).<br><br>Check the presence of absorber rods or selection of inner equipment with the correct neutron absorber content, if applicable. |
| **Part 2** | |
| 3.4 | To be complied with.<br><br>Helpful advice on criticality safety assessments is given in Appendix VI to IAEA SSG-26. Information on the use of burn up credit in criticality safety assessments of spent nuclear fuel can be found in publications from the NEA WPNCS Expert group on burn up credit criticality safety (see http://www.nea.fr/html/science/wpncs/buc/index.html) and from IAEA meetings on this topic. |
| 3.14 | 2.2.1. 2.2.1(c) and 2.2.1(d) to be complied with.<br><br>This includes 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 to be considered are e.g. water leaking into or out of the package (totally, partially), the rearrangement of the fissile material and the degradation of neutron traps.<br><br>If transported by air, then the air transport requirements of SR-6 para. 683(a) and (b) for a single package should be accounted for, whereas for arrays of packages under accident conditions of transport the testing requirements of para. 685(b) apply.<br><br>Requirements according to para. 636 of SSR-6 should be met.<br><br>See also the remarks to 1.5. |
| 3.15 | 2.2.2(c) and 2.2.2(d) to be complied with.<br><br>See also the remarks to 2.2.1. |
| 3.18 | To be complied with.<br><br>See also the remarks to 1.3, 1.5, 2.1 and 2.2.1.<br><br>The following typical items, if applicable, should be taken into account in criticality analysis (however, this list is not exhaustive):<br><br>A) Contents |

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| | i) Justifications should account for all possible configurations with any possible geometrical and physical characteristics (dimensional tolerances, positions of the components, density of powders in normal or accident conditions).<br><br>ii) If materials whose hydrogen concentration is higher than that of water can be present in the package, the demonstration of criticality safety should take account of these materials.<br><br>iii) If natural or depleted uranium could be present in the package it should be taken into account in the criticality safety justification with appropriate assumptions relative to quantities and localisation.<br><br>B) Configurations to be analysed<br><br>i) Consider proof of the sub-criticality for isolated packages under routine, normal and accident conditions of transport and arrays of packages in normal conditions of transport and accident conditions of transport.<br><br>ii) For packages where special features preventing water inleakage are considered for the criticality safety analysis for an individual package in isolation (SSR-6 para. 680):<br><br>• The criterion for water 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 a way excluding ingress of such an amount of water which could influence the criticality safety assessment. The testing conditions defined in SSR-6 para. 680 should be taken into account as well as a single error.<br><br>• The applicant should also guarantee the criticality safety of the undamaged isolated package with water penetration to cover occurrences liable during package preparation including in case of human error.<br><br>iii) Relating to air transport, the damaged isolated package should be assessed for damages resulting from Type C tests reflected by 20 cm of water, with no water penetration. In case of absence of any demonstration of the content and packaging mechanical behaviour, typical envelope configurations should be considered such as:<br><br>• fissile material (without consideration of water ingress from outside the package) in spherical shape reflected by 20 cm of water,<br><br>• the spherical fissile material (without consideration of water from outside the package) surrounded by the package reflecting materials (steel, lead…) and reflected by 20 cm of water,<br><br>• the fissile material mixed with the package moderator materials, reflected by 20 cm of water.<br><br>iv) In modelling, all the elements of structures out of steel or other materials (aluminium, titanium...) that could increase the neutron multiplication should |

be taken into account.

v) The applicant should check the qualification of criticality calculation tools and should specify the critical experiments representative of the planned transport configuration. Special attention should be paid to environments (low-moderation environments, fuel assemblies…) for which the qualification base is not really extended and for which it is desirable to use calculation models which are conservative enough (calculation assumptions) and provide margins in order to compensate for the lack of qualification, when applicable.

vi) 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 considered.

vii) It is advisable to study, for certain configurations for which the interactions can be dominating, impact of the variations of density of the fissile medium.

viii) Consider the heterogeneous shapes of the fissile materials as transported.

ix) For spent fuel initially containing plutonium, consider a conservative irradiation level that takes into account the possible evolution of reactivity during irradiation.

C) Damages to consider

i) Absence or extent of damages to fissile material in normal and accident conditions of transport should be derived from structural and thermal analysis as appropriate (see 2.2.1 and 2.2.2)[2]

ii) Absence or extent of damages to package inner structures in normal and accident conditions of transport should be derived from structural and thermal analysis as appropriate (see 2.2.1 and 2.2.2)

iii) Any damage to moderating materials in accident conditions should be taken into account.

## APPENDIX VI.

### ADDITIONAL REQUIREMENTS FOR PACKAGES CONTAINING MORE THAN 0.1 KG OF URANIUM HEXAFLUORIDE

Specific additional guidance to provide the information as requested in Part 1 and 2 of the PDSR. They apply in addition to those items belonging to the package type defined by the radioactive and fissile properties of the contents, see Annexes 2 to 5. Further guidance is also available from SSG-26.
The numbers in the first column of the table refer to paragraph numbers in this guide.

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| **Part 1** | |
| 2.2 | See ANNEX of relevant package design |
| 2.3 | See ANNEX of relevant package design |
| 2.4<br>2.5<br>2.6 | To be fully complied with - except (f).<br><br>To reflect the limits derived from all analyses in Part 2, some of these parameters may be conflicting for example temperatures and permitted radioactive contents and decay chains. |
| 2.7 | See ANNEX of relevant package design - except (g) |
| 2.8<br>2.9 | See ANNEX of relevant package design |
| 2.10 | See ANNEX of relevant package design |
| 2.11 | Compliance to para. 420 |
| 2.12 | Compliance to ISO 7195 Standard and to para. 631 of SSR-6 |
| 2.13 | See ANNEX of relevant package design |
| 2.14 | To be complied with |
| **Part 2** | |
| 3.4 | See ANNEX of relevant package design |
| 3.14 | Compliance to para. 632 a) and b) of SSR-6 |
| 3.15 | Compliance to para. 632 c) of SSR-6 |
| 3.16 | See ANNEX of relevant package design |
| 3.17 | See ANNEX of relevant package design |

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| 3.18 | See ANNEX of relevant package design |

## REFERENCES


[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 2012 Edition; IAEA Safety Standards Series No. SSR-6, IAEA, Vienna (2012)

[2] UNITED NATIONS, Recommendations on the Transport of Dangerous Goods, Eighteenth Revised Edition (ST/SG/AC.10/1/Rev.18), UN, New York and Geneva (2014).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive material, Safety Guide No.SSG-26, IAEA, Vienna (2014).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Compliance Assurance for the Safe Transport of Radioactive material, IAEA Safety Standards Series No.TS-G-1.5, IAEA, Vienna (2009).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, The Management Systems for the Safe Transport of Radioactive material, IAEA Safety Standards Series No. TS-G-1.4, IAEA, Vienna (2008).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of radiation Sources: International Basic Safety Standards – Series No. GSR Part 3, IAEA, Vienna (2014).

[7] RD-364 - Joint Canada-United-States Guide for Approval of Type B(U) and Fissile Material Transportation Packages.

**ANNEX I**

Table 1. Matrix of IAEA, 2009 and 2012 regulatory requirements and package type

| | § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| DEFINITIONS | 222 | 222 | | | | | | | | x | | *Fissile material* |
| | 225 | 225 | | | | | | x | | | | LDM |
| | 226 | 226 | | x | x | x | | | | | | LSA |
| | 239 | 239 | x | | | | x | x | x | | | Special Form Radioactive Material |
| | 241 | 241 | | x | x | x | | | | | | SCO |
| QA | 306 | 306 | x | x | x | x | x | x | x | | | Management System |
| ACTIVITY LIMITS AND CLASSIFICATION | 422-426 | 421-427 | x | | | | | | | | | §§423(e) and 424(c): transport by post |
| | 408-411 | 408-411 | | x | x | x | | | | | | LSA classification and activity limits, §410: transport by air |
| | 412-414 | 412-414 | | x | x | x | | | | | | SCO classification and activity limits |
| | 428-429 | 429-430 | | | | | x | | | | | activity limit for type A *package* |

| | § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| | 430-432 | 431-432 | | | | | | x | | | | classification as type B(U) and B(M) *package*and activity limits |
| | 433 | 433 | | | | | | x | | | | activity limits for type B(U) and B(M) *package* by air |
| | 430, 434 | 431, 432 | | | | | | | x | | | classification as type C *package* and activity limits |
| | 417, 418 | 417, 418 | | | | | | | | x | | classification as *fissile material* and restrictions |
| | 419, 420 | 419, 420 | | | | | | | | | x | classification as uranium hexafluoride and restrictions |
| REQUIREMENTS AND CONTROLS FOR TRANSPORT | 501 | 501 | | x | x | x | x | x | X | | | requirements before 1st shipment |
| | 502 | 502 | | x | x | x | x | x | x | | | requirements before each shipment |
| | 503 | 504 | | x | x | x | x | x | x | | | transport of other goods |
| | 506 | 507 | x | x | x | x | x | x | x | | | subsidiary risk |

| | § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| | 507 | 508 | x | x | x | x | x | x | x | | | non fixed contamination on *package* - §609 |
| | 514-515 | 515-516 | x | | | | | | | | | excepted *package* requirements |
| | 516 | 517 | | x | x | x | | | | | | radiation level of unshielded LSA or SCO |
| | 519 | 521 | | x | x | x | | | | | | |
| | 520 | 522 | | x | x | x | | | | | | activity limit for LSA and SCO |
| | 524 | 526 | | x | x | x | x | x | x | x | | TI and CSI limits |
| | 525,526 | 527, 528 | | x | x | x | x | x | x | | | radiation level at contact of a *package* |
| | 569 | 573 | | x | x | x | x | x | x | | | exclusive use |
| | 571 | 575 | | x | x | x | x | x | x | | | transport by sea |
| | 574 | 578 | | | | | | x | | | | transport by air for type B(M) *package* |
| REQS FOR AND PACK | 601 | 601 | | | x | x | | | | | | for LSA-III |
| | 602-604 | 602-604 | x | x | x | x | x | x | | | | for special form |

| § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| 605 | 605 | | | | | | x | | | | for LDRM |
| 606 | | | | | | | | x | | | |
| 606-616 | 607-618 | x | x | x | x | x | x | x | | | general provisions |
| 617-619 | 619-621 | x | x | x | x | x | x | x | | | transport by air and for type C *package* |
| 622 | 624 | | | x | | | | | | | IP-2 |
| 623 | 625 | | | | x | | | | | | IP-3 |
| 624 | 626 | | | x | | | | | | | alternative requirements |
| 625-628 | 627-630 | | | x | x | | | | | | alternative requirements |
| 629-632 | 631-634 | | | | | | | | | x | uranium hexafluoride |
| 634 | 636 | | x | x | x | x | x | x | x | | minimal dimensions |
| 635-645 | 637-6347 | | | | x | x | x | x | | | Type A |
| 646 | 648 | | | | x | x | b) only | b) only | | | Type A – release criteria |
| 647 | 649 | | | | x | x | x | x | | | Type A - liquids |
| 648 | 650 | | | | | x | | | | | Type A - liquids |

| | § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| | 649 | 651 | | | | | x | | | | | Type A - gases |
| | 651-655 | 653-657 | | | | | | x | x | | | |
| | 656-658 | 658-660 | | | | | | x | | | | |
| | 659-664 | 661-666 | | | | | | x | x | | | |
| | 665,666 | 667, 668 | | | | | | x | | | | B(M) only |
| | 668-670 | 670-672 | | | | | | | x | | | |
| | 671 | 673 | | | x | x | x | x | x | x | | |
| | 672 | - | x | x | x | x | x | x | x | | | fissile excepted material |
| | - | 674, 675 | x | x | x | x | x | x | x | | | fissile exempted material |
| | 673-683 | 676 - 686 | | | x | x | x | x | x | x | | |
| TEST PROCEDURES | 701 | 701 | x | x | x | x | x | x | x | x | x | demonstration of compliance |
| | 702 | 702 | | | x | x | x | x | x | x | x | assessment after tests |
| | 703 | 703 | | | x | x | | x | | | | leaching test for LSA-III and LDRM |

| § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| 704-711 | 704-711 | x | | | | x | x | x | | | tests for special form radioactive material |
| 712 | 712 | | | | | | x | | | | tests for LDRM |
| 713-715 | 713-715 | | | x | x | x | x | x | x | x | preparation of a package for testing |
| 716 | 716 | | | x | x | x | x | x | x | x | integrity of containment, shielding and assessing criticality safety |
| 717 | 717 | | | x | x | x | x | x | x | x | target for drop tests |
| 718 | 718 | | | | | | | | | x | structural test |
| 719-720 | 719-720 | | | x | x | x | x | x | x | x | general provisions for normal conditions tests |
| 721 | 721 | | | | x | x | x | x | x | | water spray test |
| 722 | 722 | | | x | x | x | x | x | x | x | free drop test |
| 723 | 723 | | | x | x | x | x | x | x | | stacking test |
| 724 | 724 | | | | x | x | x | x | x | | penetration test |

| § TS-R-1 (2009) | § SSR-6 (2012) | *Package* Type | | | | | | | Additional provisions | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | excepted | IP-1 | IP-2 | IP-3 | A | B(U), B(M) | C | Fissile | UF6 | |
| 725 | 725 | | | | | x | | | | | additional tests for Type A (liquids and gases) |
| 726 | 726 | | | | | | x | x | x | | general provisions for accident conditions tests |
| 727 (a) | 727 (a) | | | | | | x | x | x | | 9 m drop test |
| 727 (b) | 727 (b) | | | | | | x | | x | | drop test onto a bar |
| 727 (c) | 727 (c) | | | | | | x | x | x | | dynamic crush test |
| 728 | 728 | | | | | | x | | x | x | thermal test |
| 729 | 729 | | | | | | x | | x | | water immersion test |
| 730 | 730 | | | | | | x | x | | | enhanced water immersion test |
| 731-733 | 731-733 | | | x | x | x | x | x | x | | water leakage test |
| 734 | 734 | | | | | | | x | | | general provisions for Type C packages tests |
| 735 | 735 | | | | | | | x | | | puncture/tearing test |
| 736 | 736 | | | | | | | x | | | enhanced thermal test: |
| 737 | 737 | | | | | | | x | | | impact test |

**ANNEX II**
**REFERENCE DOCUMENTS USED BY COMPETENT AUTHORITIES FOR TECHNICAL ASSESSMENTS**

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| **Canada** | ** SSG-26 – Advisory material for the IAEA Regulations for the Safe Transport of Radioactive Material*<br><br>** ISO 2919 "Sealed radioactive sources - General requirements and classification"*<br><br>** ISO 9978 "Sealed Radioactive Sources - Leak Test Methods"*<br><br>** ISO 7195 "Packaging of uranium hexafluoride for transport"*<br><br>** ANSI N14.1 "Uranium Hexafluoride – Packaging for Transport"*<br><br>** ISO 12807 "Safe transport of radioactive materials -Leakage testing on packages"*<br><br>** ANSI N14.5, "Leakage Tests on Packages for Shipment of Radioactive Materials," New York, NY, 1987.*<br><br>** ANSI N14.7, Guidance for Packaging Type A - Quantities of Radioactive Materials*<br><br>** RD-364 : Joint Canada - United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages and ISO 9001* |
| **France** | ** ASN Guide N°7 – Transport – Transport of packages or radioactive materials for civil use on public domain – Rev. 1 (February 2013)*<br>*Vol. 1: Applications for package design and shipment approvals : legal context, required documentation, approval certificate template, applicant obligations, reference demonstration methods and parameters, experience feedback of assessment key issues) – Vol. 2: European PDSR (Package Design Safety Reports) guide Issue 2 (September 2012)*<br><br>** SSG-26 – Advisory material for the IAEA Regulations for the Safe Transport of Radioactive Material*<br><br>** ISO 2919 « Sealed radioactive sources - General requirements and classification»*<br><br>** ISO 9978 « Sealed Radioactive Sources - Leak Test Methods »*<br><br>** ISO 7195 « Packaging of uranium hexafluoride for transport »*<br><br>** ANSI N14.1 « Uranium Hexafluoride – Packaging for Transport »*<br><br>** ISO 12807 « Safe transport of radioactive materials -Leakage testing on* |

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| | *packages»*<br><br>** ISO 10276 «Trunnions for packages used to transport radioactive material »*<br><br>** NF EN 25-030 – « Éléments de fixation - Assemblages vissés - Partie 1 : règles générales de conception, de calcul et de montage »*<br><br>** VDI 2230 – "Systematic calculation of high duty bolted joints"*<br><br>** ROARK's Formulas for stress and strain;7th edition, Warren C. YOUNG*<br><br>** Catalogue PMDS, CEA, Tome I « Ecrans de protection contre les rayonnements ionisants »*<br><br>** NF EN 10228-3, «Essais non destructifs des pièces forgées en acier - contrôle par ultrasons des pièces forgées en aciers ferritiques et martensitiques »*<br><br>*Règle R6 Révision 4 – Assessment of the Integrity of Structures containing Defects, British Energy Generation Ltd* |
| **Germany** | ** ANSI N14.1 "Uranium Hexafluoride – Packaging for Transport"*<br><br>** BAM-GGR 007 "Leitlinie zur Verwendung von Gusseisen mit Kugelgraphit für Transport- und Lagerbehälter für radioaktive Stoffe"*<br><br>** BAM-GGR 008 "Richtlinie für numerisch geführte Sicherheitsnachweise im Rahmen der Bauartprüfung von Transport- und Lagerbehältern für radioaktive Stoffe"*<br><br>** BAM-GGR 011 "Quality Assurance Measures of Packagings for Competent Authority Approved Package Designs for the Transport of Radioactive Material"*<br><br>** BAM-GGR 012 "Leitlinie zur Berechnung der Deckelsysteme und Lastanschlagsysteme von Transportbehältern für radioaktive Stoffe"*<br><br>** DIN 25415 part 1 "Radioactively contaminated surfaces - Method for testing and assessing the ease of decontamination"*<br><br>** FKM Guideline "Fracture Mechanics Proof of Strength for Engineering Components"*<br><br>** FKM Richtlinie "Rechnerischer Festigkeitsnachweis für Maschinenbauteile"*<br><br>** IAEA TS-G-1.1 "Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material"*<br><br>** ISO 2919 "Sealed radioactive sources - General requirements and classification"*<br><br>** ISO 7195 "Packaging of uranium hexafluoride for transport"* |

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| | ** ISO 9978 "Sealed Radioactive Sources - Leak Test Methods"*<br><br>** ISO 12807 "Safe transport of radioactive materials -Leakage testing on packages"*<br><br>** KTA 3905 "Load Attaching Points on Loads in Nuclear Power Plants"*<br><br>** R6 - Assessment of the Integrity of Structures Containing Defects. British Energy Generation Ltd.*<br><br>** VDI 2230 "Systematic calculation of high duty bolted joints"*<br><br>** DIN 25712 "Criticality safety taking into account the burnup of fuel for transport and storage of irradiated light water reactor fuel assemblies in casks"*<br><br>**ICRP Publication 103, the 2007 Recommendations of the International Commission on Radiological Protection*<br><br>** ICRP 74 "Conversion Coefficients for use in Radiological Protection against External Radiation"* |
| **United States of America** | ** American Society of Mechanical Engineers, "ASME Boiler and Pressure Vessel Code, Section III, Division 3, Containment Systems and Transport Packagings For Spent Nuclear Fuel and High Level Radioactive Waste," New York, NY, 1998.*<br><br>** ANSI N14.5, "Leakage Tests on Packages for Shipment of Radioactive Materials," New York, NY, 1987.*<br><br>** American Nuclear Society, ANSI/ANS 6.1.1, "American National Standard for Neutron and Gamma-Ray Fluence to Dose Factors," La Grange Park, IL, 1991.*<br><br>** ANSI N14.1 "Uranium Hexafluoride – Packaging for Transport"*<br><br>** ISO 2919 "Sealed Radioactive Sources – General Requirements and Classification"*<br><br>** ISO 9978 "Sealed Radioactive Sources – Leak Test Methods"* |
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