

**Document Preparation Profile (DPP)  
Version 3 dated 3 April 2019**

## 1. IDENTIFICATION

**Document Category:** Specific Safety Guide

**Working ID:** DS516

**Proposed Title:** Criticality Safety in the Handling of Fissile Material

**Proposed Action:** Revision by amendment of existing Safety Guide on:

- “Criticality Safety in the Handling of Fissile Material”, 2014, Safety Standard Series No. SSG-27

**Review Committee(s):** NUSSC, RASSC, WASSC, TRANSSC, EPreSC, NSGC

**Technical Officer(s):** Ramon GATER, Juraj ROVNY

## 2. BACKGROUND

The purpose of SSG-27 *Criticality Safety in the Handling of Fissile Material* is to provide recommendations on how to meet the safety requirements for ensuring subcriticality when dealing with fissile material in the handling, processing, storage, transport and disposal of these materials and for planning the response to criticality accidents. SSG-27 presents guidance and recommendations on how to meet the requirements relating to criticality safety established in the following IAEA Safety Requirements publications: NS-R-5 on Safety of Nuclear Fuel Cycle Facilities, GSR Part 4 on Safety Assessment for Facilities and Activities, GS-R-3 on The Management System for Facilities and Activities, WS-R-5 on Decommissioning of Facilities Using Radioactive Material, SSR-6 on Regulations for the Safety Transport of Radioactive Material, SSR-5 on Disposal of Radioactive Waste and GS-R-2 on Preparedness and Response for a Nuclear or Radiological Emergency.

SSG-27 was used by many Member States as a reference when establishing national safety regulations and implementing safe practices. It may also be used as a basis for the safety evaluations conducted during IAEA missions, including Safety Evaluation of Fuel Cycle Facilities during Operation (SEDO) missions.

SSR-4 has been the governing requirements standard regarding criticality safety of fissile materials since 2017. The publication of SSR-4 in 2017 superseded IAEA Safety Standards Series No. NS-R-5, Safety of nuclear fuel cycle facilities (2014). SSR-4 introduced several requirements related to nuclear criticality safety that were previously in appendices of NS-R-5 and significantly modified the substance of other requirements. To assess the extent of these changes, a gap analysis was used to compare the requirements in SSR-4 with the previous safety requirements in NS-R-5. The requirements regarding design for criticality safety and on criticality control in operation, main safety functions, defence in depth concept, safety classification of items, safety assessment and analysis and operational limits and conditions were found to have been significantly modified. In addition, the following new requirements were established: Req.21 Design extension conditions, Req. 38 Design for criticality safety, Req. 66 Criticality control in operation and Req. 75 Interfaces between safety, nuclear security and the State system of accounting for, and control of, nuclear material. All these developments have some relation to nuclear criticality safety.

The Guide was published also before most of the General Safety Requirements including GSR Part 4 (rev.1) and GSR Part 7 and other Safety Standards publications relevant to nuclear fuel cycle facilities. As such, the Guide contains many references to superseded Safety Standards; and may not address any new requirements, if any, with implications for criticality safety.

An analysis of the scope and content of SSG-27 and the current requirements in SSR-4, GSR Part 5, GSR Part 6, SSR-5, SSR-6 and GSR Part 7 confirmed that its technical contents remain valid, but have outdated references and do not fully address all the current requirements. More detailed results of the analysis and the main revisions needed to the Guide are provided in the Annex to this DPP.

Based on the results of similar analyses, six Guides supporting SSR-4 will be revised by amendment. These will be grouped as follows:

#### Group 1

- IAEA Safety Standards Series No. SSG-5, Safety of Conversion Facilities and Uranium Enrichment Facilities, IAEA, Vienna (2010);
- IAEA Safety Standards Series No. SSG-6, Safety of Uranium Fuel Fabrication Facilities, IAEA, Vienna (2010);
- IAEA Safety Standards Series No. SSG-7, Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities, IAEA, Vienna (2010).

#### Group 2

- IAEA Safety Standards Series No.SSG-42, Safety of Nuclear Fuel Reprocessing Facilities, IAEA, Vienna (2017);
- IAEA Safety Standards Series No.SSG-43, Safety of Nuclear Fuel Cycle Research and Development Facilities, IAEA, Vienna (2017).

#### Group 3

- IAEA Safety Standards Series No. SSG-27, Criticality Safety in the Handling of Fissile Material, IAEA, Vienna (2014).

The Guide SSG-27 (Group 3) will be revised under this DPP. Groups 1 and 2 will be revised under separate DPPs. The criteria to group the Safety Guides by three DPPs are based on the gap analysis and defined by time of the publication, technical matters covered and resource allocation. Safety Guides in Group 1 (SSG-5, SSG-6 and SSG-7) were developed before publishing most of IAEA General Safety Requirements and before the accident at the Fukushima Daiichi nuclear power plant and require significant revision. Safety Guides in Group 2 (SSG-42 and SSG-43) were published recently (2017), they considered lessons learned from Fukushima-Daiichi accident and need only minor modification. SSG-27 in Group 3 covers specific area of nuclear safety – criticality safety – it is applied to all nuclear facilities where fissile materials are handled and needs involvement of specialized technical experts for revision. Another reason to divide the guides for revision into three DPPs is to adapt IAEA staff resources and to reduce pressure on Member States for reviewing the documents by applying time shift for preparing the drafts for different DPPs and for submission to Member States for reviewing.

Technical interlinkages with other revised Specific Safety Guides on safety nuclear fuel cycle facilities SSG-5, SSG-6, SSG-7, SSG-42 and SSG-43 will be considered in the revision of SSG-27.

### **3. JUSTIFICATION FOR THE PRODUCTION OF THE DOCUMENTS**

The Guide was published in 2014 to provide recommendations on fulfilling the previous Safety Requirements in NS-R-5, relating to nuclear criticality safety. It includes requirements for design features for criticality safety and criticality control in operation. Following publication of SSR-4, a

process was established for the review and revision of the associated Safety Guides related to safety of nuclear fuel cycle facilities, which covers SSG-27. It is now necessary to revise the Guide for consistency with SSR-4 to address the identified gaps.

The revision of SSG-27 will benefit from revision to take into consideration the following:

- The new and modified requirements in SSR-4 regarding criticality safety and the revision of the General Safety Requirements, along with developments in other IAEA Safety Standards;
- Long Term Structure of the IAEA Safety Standards;
- Feedback from the users of the IAEA Safety Standards related to nuclear criticality safety;
- Lessons from the accident at the Fukushima Daiichi nuclear power plant and other events in the nuclear industry, including those occurring at nuclear fuel cycle facilities that were reported to the FINAS;
- Experience gained with SEDO missions.

More specifically, amendments of the Guide are needed to address the following:

1. There are many references in the Guide to the superseded IAEA Safety Standards which should be updated.
2. As mentioned above in Section 2, there are several new requirements in SSR-4 and others have been substantively modified compared to their original form in NS-R-5. These requirements are not fully addressed in the Guide, particularly Req. 21 Design extension conditions, Req.27 Human factors engineering, Req. 38 Design for criticality safety, Req. 66 Criticality control in operation and Req. 75 Interfaces between safety, nuclear security and the State system of accounting for, and control of, nuclear material which all relate to nuclear criticality safety.
3. The content of the Guide will be checked against Appendixes and Annexes of NS-R-5 that were removed when replaced by SSR-4.
4. Some statements in the Guide that are expressed as “should” statements may now duplicate some requirements of SSR-4. Such statements should be carefully checked and either removed from the Guide or modified to make them useful recommendations, supporting the appropriate requirements.
5. In some cases, the IAEA Safety Guides have been developed to support the GSRs (e.g. SSG-41 for predisposal management of radioactive waste). These Safety Guides should be referenced in the Guides where necessary, along with other documents Safety Series that are relevant.
6. In some cases, the Guide should be updated to better reflect the current operational practices at nuclear fuel cycle facilities and the state-of-the-art in relevant technologies.
7. Analyses of operating experience and safety culture in ageing nuclear fuel cycle facilities worldwide indicate that some guidance needs to be strengthened to support Member States in enhancing criticality safety in this regard.
8. Consider interfaces between all the SSG for NCFs; the revised Guide should be compatible and consistent with other SSGs related to nuclear fuel cycle facilities.
9. Application of the graded approach to the nuclear criticality safety issues should be explained.
10. Relevant operational experience feedback will be considered when revising the Guide.

#### **4. OBJECTIVE**

The objective of the revised Guide is to provide comprehensive, consistent and up-to-date guidance for implementing the safety requirements in SSR-4 and other relevant Safety Requirements as they apply to nuclear criticality safety. It presents recommendations how to fulfil the established requirements for

ensuring criticality safety when dealing with fissile material and for planning the response to criticality accidents established in IAEA Safety Requirements: SSR-4, GSR Part 4, GSR Part 5, GSR Part 6, SSR-5, SSR-6 and GSR Part 7.

This publication is intended for use by operating organizations, regulatory bodies and other organizations involved in the nuclear criticality safety of relevant nuclear facilities and activities.

## **5. SCOPE**

The Guide covers criticality safety in the handling, processing, storage, transport and disposal of fissile materials or waste containing fissile material. The Guide makes recommendations on how to ensure subcriticality in systems involving fissile material from design through construction, commissioning and operation to decommissioning and disposal of waste. It covers all types of facilities and activities that have or use fissile material, in quantities or concentrations that pose potential hazards to workers, the public and the environment, except those that are designed to be intentionally critical, for example the core in a nuclear reactor, or a critical assembly.

In cases where criticality safety is specifically addressed by regulations, for example transport that is performed in accordance with the SSR-6, this Safety Guide supplements but does not replace the specific regulatory guidance. Amendment of SSG-27 will not contradict SSR-6 in respect to criticality detection, emergency preparedness and application of the double contingency principle.

The recommendations of this Guide should be applied to operations that are intended to remain subcritical in nuclear power plants and research reactors, for example, the handling and storage of fresh fuel and spent fuel.

The interface between safety, nuclear security, the system of accounting for, and control of, nuclear material will be addressed along the documents, as needed.

In addition, the analysis described in Section 2 resulted in identification of the main revisions to the Guide (see the Annex) that are needed to adequately address the requirements in SSR-4 and the relevant IAEA Safety Requirements.

## **6. PLACE IN THE OVERALL STRUCTURE OF THE RELEVANT SERIES AND INTERFACES WITH EXISTING AND/OR PLANNED PUBLICATIONS**

The following IAEA Safety Standards will interface with the revision of SSG-27 (the list is not intended to be final or exhaustive):

- IAEA Safety Standards Series No SSR-4, Safety of Nuclear Fuel Cycle Facilities, IAEA, Vienna (2017);
- IAEA Safety Standards Series No SSR-2/1 (Rev. 1), Safety of Nuclear Power Plants: Design, IAEA, Vienna (2016);
- IAEA Safety Standards Series No SSR-2/2 (Rev. 1), Safety of Nuclear Power Plants: Commissioning and Operation IAEA, Vienna (2016);
- IAEA Safety Standards Series No SSR-3, Safety of Research Reactors, IAEA, Vienna (2016);
- IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA, Vienna (2014);
- IAEA Safety Standards Series No. GSR Part 4, (Rev.1) Safety Assessment for Facilities and Activities, IAEA, Vienna (2016);
- IAEA Safety Standards Series No. GSR Part 5, Predisposal Management of Radioactive Waste, IAEA, Vienna (2009);

- IAEA Safety Standards Series No. GSR Part 6, Decommissioning of Facilities, IAEA, Vienna (2014);
- IAEA Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA, Vienna (2015);
- IAEA Safety Standards Series No. SSR-5, Disposal of Radioactive Waste, IAEA, Vienna (2011);
- IAEA Safety Standards Series No. SSR-6 (rev.1), Regulations for the Safe Transport of Radioactive Material, 2018 Edition IAEA, Vienna (2018);
- IAEA Safety Standards Series No. SSG-26, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, IAEA, Vienna (2012) (to be updated under DS496);
- IAEA Safety Standards Series No. SSG-5, Safety of Conversion Facilities and Uranium Enrichment Facilities, IAEA, Vienna (2010);
- IAEA Safety Standards Series No. SSG-6, Safety of Uranium Fuel Fabrication Facilities, IAEA, Vienna (2010);
- IAEA Safety Standards Series No. SSG-7, Safety of Uranium and Plutonium Mixed Oxide Fuel Fabrication Facilities, IAEA, Vienna (2010);
- IAEA Safety Standards Series No. SSG-42, Safety of Nuclear Fuel Reprocessing Facilities (2017);
- IAEA Safety Standards Series No. SSG-43, Safety of Nuclear Fuel Cycle Research and Development Facilities, IAEA, Vienna (2017);
- IAEA Safety Standards Series No SSG-15, Storage of Spent Nuclear Fuel, IAEA, Vienna (2012) (revised under DS489);
- IAEA Safety Standards Series No. SSG-30, Safety Classification of Structures, Systems and Components in Nuclear Power Plants, IAEA, Vienna (2014);
- IAEA Safety Standards Series No. SSG-41, Predisposal Management of Radioactive Waste from Nuclear Fuel Cycle Facilities, IAEA, Vienna (2016);
- IAEA Safety Standards Series No. NS-G-1.4, Design of Fuel Handling and Storage Systems in Nuclear Power Plants, IAEA, Vienna (2003) (revised under DS487);
- IAEA Safety Standards Series No. NS-G-2.5, Core Management and Fuel Handling for Nuclear Power Plants, IAEA, Vienna (2002) (revised under DS497);
- IAEA Safety Standards Series No. NS-G-4.3, Core Management and Fuel Handling for Research Reactors, IAEA, Vienna (2008) (revised under DS509);
- IAEA Nuclear Security Series No. 13, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/ Revision 5), IAEA, Vienna (2011).

Interfaces also exist with other international standards on criticality safety.

The development of this document will be coordinated with other relevant sections and divisions of NS, including Safety Assessment Section in NSNI, Transport Safety Unit in NSRW and Incident and Emergency Coordination section.

## **7. OVERVIEW**

This Section presents the proposed structure of the Guide, which will retain its overall structure at section level, with minor revisions to section titles and the organisation of subsections, to ensure adequate and comprehensive coverage of criticality-related requirements in SSR-4.

The final contents list may vary during the revision process.

The proposed structure is as follows:

1. Introduction
  - Background
  - Objective

- Scope
- Structure
- 2. General approach to criticality safety
  - General
  - Safety criteria and safety margins
  - Exemptions
  - Management system
- 3. Measures for ensuring criticality safety
  - General
  - Safety functions
  - Engineered safety measures
  - Administrative safety measures
  - Implementation and reliability of safety measures
- 4. Criticality safety assessment
  - General
  - Performance of a criticality safety assessment
- 5. Criticality safety for specific practices
  - General
  - Specific practices
- 6. Emergency preparedness and response aspects of criticality
  - General
  - Causes and consequences of a criticality accident
  - Emergency infrastructure
  - Criticality detection and alarm systems

#### References

ANNEX: Relevant literature

Contributors to drafting and review

## 8. PRODUCTION SCHEDULE

Provisional schedule for preparation of the document, outlining realistic expected dates for each step:

|   |              |
|---|--------------|
| STEP 1: Preparing a DPP   | Q3 2018      |
| STEP 2: Approval of DPP by the Coordination Committee   | Q3 2018      |
| STEP 3: Approval of DPP by the relevant review Committees   | Q4 2018      |
| STEP 4: Approval of DPP by the CSS  | Q2 2019      |
| STEP 5: Preparing the draft<br>2 consultancy meetings are expected to be organized for the preparation of the draft | Q2 – Q3 2019 |
| STEP 6: Approval of draft by the Coordination Committee   | Q3 2019      |
| STEP 7: Approval by the relevant review Committees for submission to Member States for comments                     | Q4 2019      |
| STEP 8: Soliciting comments by Member States  | Q1 2020      |
| STEP 9: Addressing comments by Member States  | Q2 2020      |
| STEP 10: Approval of the revised draft by the Coordination Committee<br>Review in NS-SSCS                           | Q4 2020      |

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| STEP 11: Approval by the relevant review Committees  | Q4 2020 |
| STEP 12: Endorsement by the CSS                      | Q4 2020 |
| STEP 13: Establishment by the Publications Committee | Q1 2021 |
| STEP 14: Target publication date                     | Q3 2021 |

## 9. RESOURCES

Staff: 10 staff weeks across NS

Consultants: 10 consultant weeks.

## ANNEX: MAIN REVISIONS TO THE GUIDE

The following tables present the main revisions to the Guide at the Section level. These revisions were identified mainly based on detailed comparison of SSR-4 with NS-R-5 and the analysis described in Section 2 of this DPP.

| Section | Main Revisions  |
|---------|---|
| 1       | <p>Standardize background, objective and scope. The background, objective and scope need to be clearly specified.</p> <p>Update references</p>  |
| 2       | <p>Check consistency and adequacy with SSR-4.</p> <p>Include information to clarify:</p> <ul style="list-style-type: none"> <li>• safety criteria and acceptance criteria;</li> <li>• prevention and mitigation design features and operational control;</li> <li>• the interface between safety, nuclear security and the State system of accounting for, and control of, nuclear material.</li> </ul> <p>Align discussion of graded approach with SSR-4 regarding the nuclear criticality safety.</p> <p>Update references</p>  |
| 3       | <p>Check consistency and adequacy with SSR-4.</p> <p>The following should be made consistent with SSR-4: terminology introduced by SSR-4 (credible abnormal conditions, conditions included in the design); the definition of concept of defence in depth; the definition of safety functions; safety classification; operational limits and conditions, design extension conditions; classification and qualification of items important to safety.</p> <p>SSR-4, Requirements 38 and 66 on design for criticality safety and criticality control in operation should be addressed fully including:</p> <ul style="list-style-type: none"> <li>• Para 6.139 of SSR-4 related to methods for ensuring criticality safety;</li> <li>• Para 6.144 of SSR-4 related to important factors for criticality (including temperature).</li> </ul> <p>Include information to clarify:</p> <ul style="list-style-type: none"> <li>• application of conservative approach;</li> <li>• definition and application of double contingency principle;</li> <li>• application of inherent safety principle;</li> <li>• means of mitigation of a criticality accident.</li> </ul> <p>Add guidance on the implementation of following requirements in relation to criticality safety:</p> <ul style="list-style-type: none"> <li>• operational limits and conditions;</li> <li>• structures, systems and components important to criticality safety;</li> <li>• maintenance, periodic testing and inspection;</li> <li>• ageing management</li> <li>• training of personal;</li> <li>• supervision;</li> <li>• records and operational documentation;</li> <li>• accountancy (material control);</li> <li>• firefighting;</li> <li>• warning notices.</li> </ul> <p>Update references</p> <p>Editorial.</p> |

|       |  |
|-------|--|
| 4     | <p>Check consistency and adequacy with SSR-4.</p> <p>Include information to clarify:</p> <ul style="list-style-type: none"> <li>• application of design extension conditions to criticality safety assessment;</li> <li>• using Criticality Safety Benchmark.</li> </ul> <p>The guidance on means of measurements and evaluation of associated uncertainties should be made consistent with SSR-4.</p> <p>Update references.</p>   |
| 5     | <p>Check consistency and adequacy with SSR-4.</p> <p>Make SSG-27 the basic document for the criticality control programme with other SSG's addressing specific criticality issues.</p> <p>Consider additional guidance where appropriate on the following for each practice:</p> <ul style="list-style-type: none"> <li>• handling;</li> <li>• storage arrangements;</li> <li>• training of personnel;</li> <li>• moderation control;</li> <li>• loading and unloading packages intended for transport.</li> </ul> <p>Expand subsection related to uranium enrichment and conversion facilities and add clarification on implementation of para 9.88b of SSR-4 on preventing criticality during the cleaning of equipment and cylinders.</p> <p>Update references.</p> |
| 6     | <p>Check consistency and adequacy with SSR-4.</p> <p>Consider additional guidance on false alarm of criticality detection and alarm systems.</p> <p>Update references.</p>   |
| Annex | Update list of relevant international standards  |