

SPESS F
Document Preparation Profile (DPP)
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(The version and date should be updated as appropriate when changes are made to the DPP.)

1. IDENTIFICATION

Document Category or batch of publications to be revised in a concomitant manner

Safety Guide

Working ID: DS566

Proposed Title: Commissioning of Nuclear Power Plants

Proposed Action: Revision of SSG-28

Review Committee(s) or Group: NUSSC, WASSC, RASSC, EPRESC

Technical Officer(s): Tetsuya Shimono

2. BACKGROUND

IAEA Safety Standards Series No. SSG-28, Commissioning of Nuclear Power Plants, was published in 2014. It provides recommendations for meeting the requirements established in SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation (2011).

SSG-28 is also used as one of the main reference publications for Pre-Operational Safety Review Team (Pre-OSART) missions, which focus on nuclear power plants during the commissioning phase.

Several IAEA Safety Standards that have links with SSG-28 have been published or revised since 2014, or are currently in the process of revision. These include:

- GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety (2016);
- GSR Part 2, Leadership and Management for Safety (2016);
- GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (2014);
- GSR Part 4 (Rev. 1), Safety Assessment for Facilities and Activities (2016);
- GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency (2015);
- SSR-2/2 (Rev. 2), Safety of Nuclear Power Plants: Commissioning and Operation (currently in preparation);
- GSG-13, Functions and Processes of the Regulatory Body for Safety (2018);
- SSG-12 (Rev. 1), Licensing Process for Nuclear Installations (currently in preparation);
- SSG-64, Operational Limits and Conditions and Operating Procedures for Nuclear Power Plants (2020);
- SSG-71, Modifications to Nuclear Power Plants (2022);
- SSG-72, The Operating Organization for Nuclear Power Plants (2022);
- SSG-74, Maintenance, Testing, Surveillance and Inspection in Nuclear Power Plants (2023);

- SSG-75, Recruitment, Qualification and Training of Personnel for Nuclear Power Plants (2023).

In addition, there have been significant developments in nuclear technology, regulatory practices and international experience since 2014, including the following:

- The deployment of advanced reactor designs, each of which brings novel commissioning challenges;
- The increasing integration of digital instrumentation and control (I&C) systems into commissioning activities;
- Updated commissioning procedures and verification steps, needed as a result of safety enhancements following the accident at the Fukushima Daiichi nuclear power plant;
- Expanded international operating experience and lessons learned in the areas of commissioning delays, quality assurance and safety culture;
- Integration of risk informed approaches and probabilistic safety assessments into commissioning oversight;

A feedback analysis report is attached to this DPP specifying the main aspects that should be considered when revising SSG-28.

3. JUSTIFICATION FOR THE PRODUCTION OF THE PUBLICATION

As a result of the new Safety Standards and the developments detailed in Section 2, a revision of SSG-28 is needed to ensure its continued relevance and its alignment with current Safety Standards and practices.

A revision of the Safety Guide will support users by:

- Providing recommendations to meet the updated SSR-2/2 (Rev. 2) requirements;
- Incorporating experience from the commissioning of new NPPs over the last decade;
- Taking account of lessons learned from events reported to the International Reporting System for Operating Experience (IRS);
- Using the experience from application of SSG-28 during Pre-OSART missions;
- Reflecting specific commissioning aspects of advanced reactor designs and novel technologies;
- Enhancing risk management and contingency planning as part of commissioning management systems;
- Incorporating lessons learned from the commissioning of NPPs restarted after an extended shutdown period.

4. OBJECTIVE

The objective of this revision is to supplement and update the existing Safety Guide based on practical experience gained from its use, and to incorporate necessary changes that ensure comprehensive recommendations on the commissioning of NPPs.

The revised Safety Guide aims to support operating organizations and regulatory bodies, as well as other stakeholders involved in commissioning as appropriate, in ensuring the effective planning, implementation and oversight of commissioning activities.

5. SCOPE

The overall scope of the revised publication will remain essentially unchanged.

However, whereas the scope of SSG-28 covered the commissioning of land based stationary nuclear power plants of all types, the revision will also consider, where appropriate, specific aspects relevant to floating or transportable nuclear power plants.

The Safety Guide will cover the organization and management of commissioning activities, the establishment and implementation of commissioning programmes and tests, and the interfaces among the organizations involved, including the regulatory body. It will include the following elements of commissioning:

- Pre-commissioning activities such as verification of construction quality, documentation, and readiness reviews;
- Commissioning stages such as cold performance tests, hot performance tests, fuel loading, initial criticality and power ascension tests;
- Digital and automated systems including aspects such as validation, cybersecurity and integration into commissioning;
- Safety culture and human factors in commissioning teams;
- Regulatory oversight and international peer review mechanisms;
- Risk informed approaches to commissioning planning and execution.

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

The place of the Safety Guide in the overall structure will not change; it will continue providing recommendations on meeting the requirements established in SSR-2/2 (Rev. 2).

Any links with the IAEA Safety Standards listed in Section 2 will be taken into consideration in the revision of SSG-28.

7. OVERVIEW

It is not planned to significantly change the structure of the current publication:

Section 1 will comprise an introduction.

Section 2 will cover the commissioning process, including the objectives of commissioning, the development and execution of the commissioning programme, and the respective roles of the operating organization and the regulatory body.

Section 3 will provide recommendations on the organization and management of commissioning, addressing management systems, organizational arrangements, functions and responsibilities, interfaces among participating organizations, and arrangements for resources, training and emergency preparedness.

Section 4 will provide recommendations on the implementation of the commissioning programme, including the planning, preparation and execution of commissioning tests, the review and evaluation of test results, and the handling of deviations. Some additional information — such as lessons learned from Pre-OSART missions and relevant operating experience from events at nuclear power plants — will be incorporated into Section 4 to strengthen the recommendations and provide better understanding for users. The revision will take into account technological developments since the publication of SSG-28, such as new commissioning approaches for small modular reactors (SMRs), testing considerations for multi-module configurations, and practices related to digital I&C systems.

Section 5 will provide recommendations on documentation for commissioning, specifying the arrangements, scope and structure of the documents required to support and record commissioning activities.

8. PRODUCTION SCHEDULE:

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

STEP 1: Preparing a DPP	DONE
STEP 2: Internal review of the DPP (Approval by the Coordination Committee)	Q1 2026
STEP 3: Review of the DPP by the review Committee(s) (Approval by review Committee(s))	Q2 2026
STEP 4: Review of the DPP by the CSS (approval by CSS) or information of the CSS on the DPP	Q4 2026
STEP 5: Preparing the draft publication	Q2 2027
STEP 6: First internal review of the draft publication (Approval by the Coordination Committee)	Q3 2027
STEP 7: First review of the draft publication by the review Committee(s) (Approval for submission to Member States for comments)	Q4 2027
STEP 8: Soliciting comments by Member States	Q2 2028
STEP 9: Addressing comments by Member States	Q4 2028
STEP 10: Second internal review of the draft publication (Approval by the Coordination Committee)	Q1 2029
STEP 11: Second review of the draft publication by the review Committee(s) (Approval of the draft)	Q2 2029
STEP 12: (For Safety Standards) Editing of the draft publication in MTCD and endorsement of the draft publication by the CSS	Q4 2029
STEP 13: Approval by the Board of Governors (for SF and SR only)	-
STEP 14: Target publication date	Q2 2030

The schedule is in line with the NSNI Operational Safety Section's long-term plan on the development and revision of IAEA Safety Standards.

9. RESOURCES

Estimated resources involved by the Secretariat (person-weeks) and the Member States (number and type of meetings)

- Estimated Secretariat staff resources: 16 person-weeks in 3 years
- 2 consultancy meetings: 40 person-weeks
- 1 technical meeting: 40 person-weeks

ANNEX

Feedback analysis report

During the review process, the following feedback and considerations will be analysed, discussed, and incorporated into the revised publication. The aim is to ensure that the Safety Guide remains aligned with current IAEA Safety Standards, reflects international operating experience, and addresses emerging challenges in nuclear power plant commissioning.

1. Member States' experience

- **Commissioning of new NPPs:** Practical lessons learned from recent projects worldwide, including challenges in schedule management, quality assurance, and integration of advanced technologies.
- **Multi-unit and series commissioning:** More detailed criteria for when it is acceptable to omit or modify specific tests for identical units in a multi-unit plant or for a series of identical designs, ensuring safety is not jeopardized.
- **Restart of NPPs after extended shutdowns:** Experience from Japan and other Member States where plants have undergone recommissioning following long outages, highlighting unique safety and organizational issues.
- **International peer reviews:** Insights gained from Pre-OSART missions, which have used SSG-28 extensively as a reference, will be systematically analysed to identify gaps and strengthen guidance.

2. Updates to Safety Requirements

- **SSR-2/2 (Rev. 2):** Incorporation of additional requirements introduced in the latest revision, ensuring full consistency between the Safety Guide and the Safety Requirements.
- **Cross-references to related Safety Standards:** Updates will reflect recent publications such as SSG-71 (*Modifications to Nuclear Power Plants*), SSG-72 (*The Operating Organization for Nuclear Power Plants*), and SSG-75 (*Recruitment, Qualification and Training of Personnel for Nuclear Power Plants*).
- **Integration with GSR Part 2 and GSR Part 4:** Strengthening the link between commissioning activities and leadership and management for safety, and safety assessment processes.
- Ongoing or planned updates of SSR-2/1 (Rev. 1), GSR Part 2 and other relevant standards will also be taken into account during the drafting.

3. Operating experience and lessons learned

- **Events reported to IRS (International Reporting System for Operating Experience):** Analysis of commissioning related events, deviations and corrective actions to inform practical recommendations.
- **Human factors and safety culture:** Emphasis on organizational readiness, training and human factors, based on lessons learned from commissioning teams worldwide. Enhanced guidance on managing the transition of personnel from construction to operation. This includes improving safety culture to ensure managers and supervisors can effectively recognize and correct inappropriate behaviours during the commissioning phase.

4. Technological developments

- **SMR and innovative reactor integration:** Specific guidance for small modular reactors (SMRs) and non-water-cooled designs is a high priority. Guidance will be expanded to address commissioning aspects of SMRs, Generation III+ reactors, and innovative designs. Revision should address deployment models like factory-based commissioning versus on-site activities for transportable units.
- **Multi-module interdependency:** In multi-unit SMR sites, a unique hold point is needed to verify that commissioning a new module does not impact the safety or operation of those already running.
- **Digital I&C and remote monitoring:** Updated recommendations for commissioning modern digital instrumentation and control (I&C) systems, including the use of remote monitoring capabilities and real-time information systems. Reasonably incorporating advanced digital technologies, such as artificial intelligence and machine learning, to improve commissioning processes, enhance safety, and reduce human error. Recommendations will cover validation, cybersecurity and integration of digital systems into commissioning programmes.
- **Digital configuration management:** Recommendations should include the use of digital twins or building information modelling for the handover of ‘as-built’ documentation. This ensures that the operating organization receives an accurate digital representation of the plant’s state.
- **Multi-unit and series commissioning:** More detailed criteria for when it is acceptable to omit or modify specific tests for identical units in a multi-unit plant or for a series of identical designs, ensuring safety is not jeopardized.
- **First-of-a-kind (FOAK) adjustments:** Explicit recommendations for the licensing and commissioning of FOAK reactors, where design-specific data might be limited.
- **Risk informed commissioning:** Adopting a risk informed approach to commissioning, focusing on identifying and mitigating potential hazards and risks associated with nuclear power plant operation. Consideration of modern tools for simulation, predictive testing and risk informed oversight.
- **Transition management system:** The revision should include recommendations on a management system that specifically governs the transition period, clearly defining the shift in authority and the point at which operational limits and conditions (OLCs) become binding.
- **Early operating personnel involvement:** Guidance should recommend the involvement of operating group personnel during the construction and early commissioning phases (e.g. witnessing installation/testing) to build technical competence before they assume full responsibility.
- **Enhanced training and competence development:** Developing comprehensive training programmes for commissioning personnel, focusing on emerging technologies, safety procedures and emergency response.
- **International collaboration and knowledge sharing:** Strengthening international cooperation and knowledge sharing among Member States to facilitate the exchange of best practices, lessons learned and innovative solutions.

5. Regulatory and oversight practices

- **Interfaces between operating organizations and regulatory bodies:** Strengthened guidance on approval, authorization and supervision during commissioning.

- **Risk informed regulatory approaches:** Incorporation of probabilistic safety assessment (PSA) insights into commissioning oversight.
- **International harmonization:** Alignment with global best practices to support newcomer countries and ensure consistency across Member States.
- **Regulatory collaboration:** Encouraging collaboration among regulatory bodies from different Member States when commissioning the same design simultaneously in multiple jurisdictions to reduce regulatory burden.
- **Safety-security interface:** Strengthening the integration of computer security and physical protection during the commissioning phase. This ensures that testing activities do not inadvertently create vulnerabilities or compromise physical security systems.

6. Documentation and programme control

- **Commissioning documentation:** Clearer recommendations on the preparation, structure and retention of commissioning records.
- **Change management:** Enhanced guidance on controlling modifications to commissioning programmes, including regulatory approval processes.
- **Knowledge management:** Emphasis on capturing and transferring lessons learned for future projects.
- **Test acceptance criteria and management of non-conformances:** Clarifying and further developing the test acceptance criteria and the processes for identifying, documenting and resolving non-conformances, in line with the expectations set out in SSR-2/2 (Rev. 2).

7. SMR-specific technical test sequences

The revision should transition from strictly site-centric sequences to a hybrid factory-site model to reflect SMR modularity.

- **Factory-based pre-commissioning:** Guidance should be added for factory acceptance testing (FAT) that serves as a formal commissioning credit. This includes full-system verification of factory-assembled modules before transport, reducing the site-testing burden.
- **Passive safety system verification:** SMRs rely heavily on passive features (e.g. natural circulation, gravity-fed cooling). Test sequences should include specific protocols for verifying these flows under low pressure or varied thermal conditions that may not be fully covered in current ‘hot functional’ testing.
- **Shared system testing:** For multi-module SMR plants, the revision should detail sequences for testing shared structures, systems and components (SSCs). This ensures that commissioning one module does not adversely affect another module already operating.
- **Reduced scope for identical units:** Explicit criteria should be established for series commissioning, allowing for a reduced test scope for ‘Nth-of-a-kind’ units based on data from the FOAK unit, provided that safety is not compromised.

8. Handover process: Construction to operation

A major improvement in SSG-28 would be more prescriptive guidance on the interface and transfer phase to prevent ‘knowledge gaps’ during the transition.

- **Phased handover protocols:** Instead of a single ‘handover event’, the revision should promote a phased transfer where responsibility for specific systems moves from the construction group to the commissioning group, and finally to the operating group as they are verified functional.
- **Digital configuration management:** Recommendations should include the use of digital twins or building information modelling for the handover of ‘as-built’ documentation. This ensures that the operating organization receives an accurate digital representation of the plant's state.
- **Early operating personnel involvement:** Guidance should recommend the involvement of operating group personnel during the construction and early commissioning phases (e.g. witnessing installation/testing) to build technical competence before they assume full responsibility.
- **Transition management system:** The revision should include recommendations on a management system that specifically governs the transition period, clearly defining the shift in authority and the point at which operational limits and conditions (OLCs) become binding.

In summary, the revision of SSG-28 should build upon Member States’ experience, updated IAEA Safety Standards, and lessons learned from recent commissioning projects. It should expand guidance to cover advanced technologies, reinforce safety culture, and strengthen regulatory interfaces. The revised Safety Guide should provide comprehensive, practical and harmonized recommendations to support the safe and effective commissioning of nuclear power plants worldwide.