

**Document Preparation Profile (DPP)  
Version 3 dated 16-05-2014**

## **1. IDENTIFICATION**

**Document Category**    **Safety Guide**

**Working ID:**            **DS488**

**Proposed Title:**        **Design of the Reactor Core for Nuclear Power Plants**

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

- **“Design of the Reactor Core for Nuclear Power Plants”, 2005, Safety Standard Series No. NS-G-1.12**

**Review Committee(s) or Group:**    **NUSSC**

**Technical Officer(s):**    **K.S. Sim / NSNI**

## **2. BACKGROUND**

The purpose of the Safety Guide is to provide recommendations on how to meet safety requirements for the design of the core for thermal nuclear power plants (NPPs) established in Specific Safety Requirements document SSR-2/1 (currently under final review by SCCs). The Safety Guide deals with important safety features that should be considered in the design of the NPP, from the aspects of reactor physics; core thermal hydraulics; mechanical, chemical and irradiation performance of the individual systems and components of the core in the land based-nuclear power plants with water cooled reactors.

After the publication of the new Specific Safety Requirements for NPP Design (SSR-2/1) in 2012, a process has been established for the review and revision of the associated Safety Guides.

As part of the IAEA Action Plan<sup>1</sup> on Nuclear Safety, activities are ongoing to review and strengthen safety standards and improve their implementation. The revision of the Safety Guide is also proposed, under the same framework, to reflect lessons learned from the accident at the Fukushima Daiichi NPP in 2011. A gap assessment<sup>2</sup> for Specific Safety Requirements in SSR-2/1 with respect to the lessons learned from the Fukushima Daiichi accident showed a need to reinforce the application of defence in depth concept for severe accident. That is, in design it is needed to include provisions to avoid short-term cliff-edge effect in case of an extreme external hazard of an intensity or a duration of accident exceeding the one considered as the general design basis (design extension conditions).

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

Many sections in the governing requirements document SSR-2/1, including a section for fuel handling and storage systems, are being revised to reflect lessons learned from the Fukushima Daiichi accident in 2011 under project DS462. Therefore, the revision of NS-G-1.12 should also take place in line with developing process of DS462 for revision of SSR-2/1.

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<sup>1</sup> <http://www-ns.iaea.org/actionplan/default.asp>

<sup>2</sup> “CSS–SECRETARIAT PROGRESS REPORT ON THE REVIEW OF THE IAEA SAFETY STANDARDS IN THE LIGHT OF THE FUKUSHIMA DAIICHI ACCIDENT”, Revision 8, 23 February 2012.

Furthermore, the current NS-G-1.12 was issued in 2005 based on the previous Specific Safety Requirements document (NS-R-1, issued in 2000), while the previous requirements document NS-R-1 was superseded by the new Specific Safety Requirements document (SSR-2/1) in 2012. Hence, additional requirements related to core design in SSR-2/1 need to be captured in Safety Guide NS-G-1.12.

The document for Long-Term Structure of the IAEA Safety Standards and Current Status<sup>3</sup> also indicates the necessity of revising the out-dated Safety Guide.

#### **4. OBJECTIVE AND SCOPE**

This Safety Guide is intended to provide recommendations concerning safety features for incorporation into the design of the reactor core for a NPP.

This publication is intended for use by organizations designing, manufacturing, constructing, and operating NPPs, as well as by regulatory bodies.

This publication is intended for application to thermal nuclear reactors that are land based. It addresses the following aspects of core design:

- The neutronic, thermal, hydraulic, mechanical, chemical and irradiation considerations that are important for the safe design of the core of a NPP;
- The individual systems and components that make up the core, the equipment associated with the core and the design provisions for the safe operation of the core;
- The internals of the reactor vessel and the devices mounted on the reactor vessel for reactivity control and shutdown;
- The fuel assemblies and those structures that hold the fuel assemblies and other components in a predetermined geometrical configuration;
- The moderator and the coolant within the core;
- The components and structures used for reactivity control and shutdown, comprising the neutron absorbers (solid or liquid), the associated structure and drive mechanism, and related components of the fluid system;
- The support structures that provide the foundation for the core within the reactor vessel, the structure for guiding the flow, such as the core barrel or the pressure tubes of a PHWR, and guide tubes for reactivity control devices; and
- Other reactor vessel internals such as instrumentation tubes, in-core instrumentation for core monitoring, steam separators and neutron sources.

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

This Safety Guide will provide guidance on compliance with relevant aspects of the Safety Requirements on: Safety Assessment for Facilities and Activities (GSR Part 4, 2009); and Safety of Nuclear Power Plants: Design (SSR-2/1, 2012).

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<sup>3</sup>

<http://www-ns.iaea.org/committees/files/CSS/205/status.pdf>

The following IAEA documents to be interfaced with revision of NS-G-1.12:

- “Fundamental Safety Principles”, SF-1, 2006.
- “Safety of Nuclear Power Plants: Design”, SSR-2/1, 2012. (To be updated under DS462 and DS465.)
- “Safety of Nuclear Power Plants: Commissioning and Operation”, SSR-2/2, 2012. (To be updated under DS462 and DS467.)
- “Safety Assessment for Facilities and Activities”, GSR Part 4, 2009. (To be updated under DS462 and DS466.)
- “Instrumentation and Control Systems Important to Safety in Nuclear Power Plants”, NS-G-1.3, 2002.
- “Design of Fuel handling and Storage Systems for Nuclear Power Plants”, NS-G-1.4, 2003. (To be updated under DS487.)
- “External Events Excluding Earthquakes in the Design of Nuclear Power Plants”, NS-G-1.5, 2003.
- “Seismic design and Qualification for Nuclear Power Plants”, NS-G-1.6, 2003.
- “Protection against Internal Fires and Explosions in the Design of Nuclear Power Plants”, NS-G-1.7, 2004.
- “Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants”, NS-G-1.9, 2004. (To be updated under DS481.)
- “Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants”, NS-G-1.11, 2004.
- “Core Management and Fuel Handling for Nuclear Power Plants”, NS-G-2.5, 2002.
- “Evaluation of Seismic Safety for Existing Nuclear Installations”, NS-G-2.13, 2009.
- “Severe Accident management Programmes for Nuclear Power Plants”, NS-G-2.15, 2009. (To be updated under DS483.)
- “Deterministic Safety Analysis for Nuclear Power Plants”, SSG-2, 2009.
- “The Management System for Facilities and Activities”, GS-R-3, 2006. (To be updated under DS456.)

None of Nuclear Security publications are identified relevant to the Guide.

## 6. OVERVIEW

The table of contents (TOC) is proposed as attached.

The final contents may vary during the revision process. The majority of the text that will be reviewed and incorporated, with revisions where necessary, in the new Safety Guide is available or is being developed concurrently.

## 7. PRODUCTION SCHEDULE

STEP 1: Preparing a DPP	DONE
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STEP 2: Approval of DPP by the Coordination Committee	April 2014
STEP 3: Approval of DPP by the relevant review Committees	Q3, 2014
STEP 4: Approval of DPP by the CSS	Q4, 2014
STEP 5: Preparing the draft	Q2, 2015
STEP 6: Approval of draft by the Coordination Committee	Q3, 2015
STEP 7: Approval by the relevant review Committees for submission to Member States for comments	Q1, 2016
STEP 8: Soliciting comments by Member States	Q3, 2016
STEP 9: Addressing comments by Member States	Q1, 2017
STEP 10: Approval of the revised draft by the Coordination Committee Review in NS-SSCS	Q2, 2017
STEP 11: Approval by the relevant review Committees	Q3, 2017
STEP 12: Endorsement by the CSS	Q4, 2017
STEP 13: Establishment by the Publications Committee and/or Board of Governors (for SF and SR only))	Q1, 2018
STEP 14: Target publication date	Q2, 2018

## 8. RESOURCES

It is estimated to revise the Safety Guide as:

- P staff (25 man weeks)
- Four (4) CS meetings; 20 person weeks of non-staff
- Technical Meeting.

Attachment:

**Tentative Table of Contents**

The proposed TOC is made, based on TOC of the original document.

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1. Introduction
  - Background
  - Objective
  - Scope
  - Structure
2. General Safety Considerations in Design
  - General
  - Neutronic Design
  - Thermal-Hydraulic Design
  - Mechanical Design
  - Safety Classification Aspects of Core Design
3. Specific Safety Considerations in Design
  - General
  - Fuel Elements and Assemblies
  - Coolant
  - Moderator
  - Core Reactivity Characteristics and Means of Control of Reactivity
  - Reactor Shutdown Systems
  - Reactor Core and Associated Structures
  - Core Management
  - Core Monitoring System
  - Safety Analysis
4. Qualification and Testing
  - General
  - Equipment Qualification
  - Provision for Inspection and Testing
5. Management System for Design

Appendix I: Reactivity Coefficients

Appendix II: Fuel Pellet-Cladding Interaction

Appendix III: Design Considerations for Core Management

Appendix IV: High Burnup Fuel Cores

Appendix V: Mixed Oxide Fuel Cores

References