Document Preparation Profile (DPP)
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1. IDENTIFICATION

Document Category: **Safety Guide**

Working ID: **DS483**

Proposed Title: **Severe Accident Management Programme for Nuclear Power Plants**

Proposed Action: **Revision of existing guide on severe accident management programme for nuclear power plants**

Review Committee(s) or Group: **NUSSC, WASSC and NSGC**

Technical Officer(s): **Peter. J. Hughes (lead), Manwoong Kim**

2. BACKGROUND

The IAEA Safety Guide No.: NS-G-2.15, Severe Accident Management Plan (SAMP) for Nuclear Power Plants (NPPs) was issued in 2009 aimed at giving guidance on how such measures should be defined and how they should be executed. It provides which steps should be taken in setting up an accident management program, from the conceptual stage down to a complete set of instructions - procedures and guidelines - to the plant operators. In addition, this Safety Guide provides guidance on compliance with the regulatory aspects of the Safety Requirements on: Safety Assessment and Verification for Nuclear Facilities (GSR Part 4, 2009) in particular with requirement 13; Safety of Nuclear Power Plants: Design (SSR-2/1, 2012); and Safety of Nuclear Power Plants: Commissioning and Operation, (SSR-2/2, 2011).

However, following issuing NS-G-2.15, the events of September 11, 2001 attack in USA and all NPPs adopted mitigation strategies using readily available resources to maintain or restore core cooling, containment, and used fuel pool cooling capabilities to cope with the loss of large areas of a facility due to large fires and explosions from any cause including aircraft impacts and natural phenomena such as earthquakes, tornadoes, floods, and tsunami that are beyond the design basis. Moreover, the Fukushima Daiichi accident caused by an earthquake and tsunami in 2011 showed opportunities to further strengthen the guidelines.

3. JUSTIFICATION FOR THE PRODUCTION OF THE DOCUMENT

As noted above, there is a need to revise the current NS-G-2.15 that is provided to guidelines of SAMP for nuclear power plants with lessons learned from Fukushima accident experience because it was found there are opportunities to further strengthen this guide. In other word, the NS-G-2.15 needs to extend its guidance to core/debris cooling, removal of decay heat and long-term cooling, and maintaining containment integrity. Additional challenges are placed on cooling with non-qualified sources, run-off of contaminated water, threats from the spent fuel cooling, and large-scale natural events at multi-unit sites. Shutdown conditions are also considered. It includes conditions where command and control for the event have been lost, where there is large-scale damage on the site, where major safety functions such as control of reactivity, removal of heat from the core and from spent fuel, confinement of radioactive material and limitation of accidental radioactive releases have been lost, and either must be repaired under difficult circumstances or must be replaced by portable

equipment, which is either stored on-site storage or brought in by road or in air transport from an off-site storage.

Therefore, the revision of NS-G-2.15 will place a high demand on a comprehensive overview of accident management programme for nuclear power plants so that it will be considered during the design of accident management, operating experience, and areas where improvements, including new methodologies or technologies may be needed.

In addition, the relevant Safety Requirements, NS-R-1 and NS-R-2 in this field are more than ten years old and these relevant Safety Requirements have been revised and replaced as SSR-2/1 and SSR-2/2 in 2012 and 2011 respectively.

Furthermore, according to the IAEA Action Plan on Nuclear Safety in response to the Fukushima Daiichi event, there is a need to revise Safety Standards including GSR Part 4, SSR-2/1, SSR-2/2 and NS-G-2.15 to provide guidance to the Member States with reflecting current knowledge, experience and best practices in this area.

More information is provided in the feedback analysis report in annex to the DPP (ANNEX 1).

4. OBJECTIVE AND SCOPE

The objective of this Safety Guide is to provide practical guidance and recommendations for the development of an accident management programme as defined in relevant requirement in GSR Part 4, SSR-2/1 and SSR-2/2 aimed at preventing and/or to mitigating the consequences of design extension conditions for beyond design basis accidents and severe accidents. In addition, it is also considered to be managed for accidents resulting from events or combination of deficiencies not considered in the design basis, including external events.

In addition this Safety Guide will address preparation, development, implementation and review of accident management programs for the development of a severe accident management programme. The recommendations of this Safety Guide will be developed for severe accident management during all operating conditions for both reactor and spent fuel pool.

This guideline will also contain guidance on drills / exercises. It will give guidance on how such measures should be defined and how they should be executed to support harmonization of methods used by Member States. It comprises the main elements for accident management in a complete and consistent way with current NS-G-2.15. It is applicable for all LWRs (e.g. PWR, BWR and VVER) and PHWRs, but its basic philosophy and approach are anticipated to remain valid for other reactors such as RBMK.

Therefore, this Safety Guide is intended primarily for use by operating organizations of nuclear power plants, utilities and their support organizations to assist implementation of the severe accident management programme, but also is useful for regulatory bodies to prepare the relevant national regulatory requirements. Furthermore, this guide is also useful for other national organizations involved in emergency response planning and preparedness.

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 the regulatory aspects of the Safety Requirements on: Safety Assessment and Verification for Nuclear Facilities (GSR Part 4, 2009) in particular with requirements 13; Safety of Nuclear Power Plants: Design (SSR-2/1, 2012); and Safety of Nuclear Power Plants: Commissioning and Operation, (SSR-2/2, 2011).

The following IAEA documents to be interfaced with revision of NS-G-2.15:

- Safety Assessment and Verification for Nuclear Facilities, No. GSR Part 4, IAEA, Vienna (2009)
- Safety of Nuclear Power Plants: Design, No. SSR-2/1, IAEA, Vienna (2012)
- Safety of Nuclear Power Plants: Commissioning and operation, No. SSR-2/2, IAEA, Vienna (2012).

In addition, a list of documents that need to be taken into account is listed below:

Safety Standards

- Fundamental Safety Principles, No. SF-1, IAEA, Vienna (2006);
- Safety Assessment and Verification for Nuclear Facilities, No. GSR Part4, IAEA, Vienna (2009);
- Safety of Nuclear Power Plants: Design, No. SSR-2/1, IAEA, Vienna (2012);
- Safety of Nuclear Power Plants: Commissioning and Operation, No. SSR-2/2, IAEA, Vienna (2011);
- Severe Accident Management Programme for NPPs, No. NS-G-2.15, IAEA, Vienna (2009);
- Safety Assessment and Verification for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.2, IAEA, Vienna (2001);
- Design of Reactor Containment Systems for Nuclear Power Plants, IAEA Safety Standards Series No. NS-G-1.10, IAEA, Vienna (2004);
- Preparedness and response for a nuclear or radiological emergency, IAEA Safety Standards Series No.GS-R-2, IAEA Vienna (2002); and
- Preparedness and Response for a Nuclear or Radiological Emergency, IAEA draft General Safety Requirements Series No. DS457 (future GSR Part 7).

Safety Report Series

- Implementation of Accident Management Programmes in Nuclear Power Plants, Safety Report No. 32, IAEA, Vienna (2004);
- Guidelines for the Review of Accident Management Programmes, Safety Service Series No.9, IAEA, Vienna (2003);
- Severe Accident Analysis Tools, SRS No. 56, IAEA, Vienna (2008); and
- Development and Review of Plant Specific Emergency Operating Procedures, Safety Reports Series No. 48, IAEA, Vienna (2006).

Services Series

- Guidelines for the review of accident management programmes in nuclear power plants, IAEA Services Series No. 9 (2003).

TECDOC

- Application of Simulation Techniques for Accident Management Training in NPPs, IAEA TECDOC-1352 (2003);
- Overview of Training Methodology. for Accident Management at Nuclear Power Plants, IAEA TECDOC-1440 (2005);
- Analysis of Severe Accidents in Pressurized Heavy Water Reactors, IAEA TECDOC-1594 (2006).

The list is not intended to be final or exhaustive

6. OVERVIEW

Although the table of contents will be in compliance with current Safety Guide, 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. An outline of the contents is set out in ANNEX 2 but the final contents may vary during the drafting process.

This Safety Guide consists of three main sections. Section 1 describes introduction and Section 2 presents the overall concept of an accident management programme. High level considerations are described in Section 2, while the process of development and implementation of an accident management programme is treated in Section 3. Recommendations for the use of severe accident management guidelines (SAMG) are described in an appendix. An example of a categorization scheme for accident sequences is provided in an annex.

More detailed information is provided in ANNEX 2.

7. PRODUCTION SCHEDULE:

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

	Safety Guide
STEP 1: Preparing a DPP	DONE
STEP 2: Approval of DPP by the Coordination Committee	2013 Q-3
STEP 3: Approval of DPP by the relevant review Committees	2013 Q-4
STEP 4: Approval of DPP by the CSS	2014 Q-1
STEP 5: Preparing the draft	2014 Q-2
STEP 6: Approval of draft by the Coordination Committee	2014 Q-3
STEP 7: Approval by the relevant review Committees for submission to Member States for comments	2014 Q-4
STEP 8: Soliciting comments by Member States	2015 Q-2
STEP 9: Addressing comments by Member States	2015 Q-4
STEP 10: Approval of the revised draft by the Coordination Committee Review in NS-SSCS	2016 Q-1
STEP 11: Approval by the relevant review Committees for submission to the CSS	2016 Q-2
STEP 12: Endorsement by the CSS	2016 Q-4
STEP 13: Establishment by the Publications Committee and/or Board of Governors (for SF and SR only))	
STEP 14: Target publication date	2017 Q-3

8. RESOURCES

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

Most of the preparatory work for this report such as review of feedback experiences from review of accident management programme implementation and from gap reviews of lessons learned from Fukushima Daiichi accident has been performed.

It is estimated to revise the Safety Guide as:

2013:
2 Consultancy Meetings to revise, 1 Consultancy Meeting to review 1st draft.
Lead TO - 3 weeks, other TOs - 6 weeks, one support staff - 3 weeks (to collect comments and prepare review).

2014:
3 Consultancy Meetings to address comments and to finalize.
Lead TO - 3 weeks, other TOs - 10 weeks, one support staff - 5 weeks.

2015:
2 Consultancy Meetings to review final draft.
Lead TO – 3 weeks, other TOs – 6 week.

2016:
2 Consultancy Meetings to review final draft.
Lead TO – 3 weeks, other TOs – 6 week.

ANNEX 1

FEEDBACK ANALYSIS REPORT – Safety Guide on Severe Accident Management Programme for Nuclear Power Plants

The objective of the feedback report is to provide a justification for a revision to the safety standards based on a systematic collection and analysis of feedback from the use of the safety standards as described in Strategies and Processes for the Establishment of the IAEA Safety Standards (SPESS).

1. Revision for consistency with revision of relevant Safety Requirements; GSR Part 4, SSR-2/1 and SSR-2/2

The IAEA Action Plan on Nuclear Safety, which was developed in response to the accident at TEPCO's Fukushima Daiichi nuclear power plant following the Great East Japan Earthquake and Tsunami of 11 March 2011, and which was approved by the International Atomic Energy Agency's (IAEA's) Board of Governors and endorsed by the IAEA General Conference in September 2011, includes an action headed: "Review and strengthen IAEA Safety Standards and improve their implementation". This action calls upon the Commission on Safety Standards (CSS) and the IAEA Secretariat to review, and revise as necessary using the existing process in a more efficient manner, the relevant IAEA safety standards in a prioritized sequence.

In 2011 the Secretariat started a review of Safety Requirements publications in the IAEA Safety Standards Series on the basis of information that was available on the Fukushima Daiichi accident, including two reports from the Government of Japan issued in June and September 2011, the report of the IAEA International Fact Finding Expert Mission conducted in Japan from 24 May to 2 June 2011, and a letter from the Chairman of the International Nuclear Safety Group (INSAG) dated 26 July 2011. Additional inputs were considered, including the findings of international experts' meetings and presentations made at the Second Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety in August 2012. Several national and regional reports were also analysed. On that basis, the Safety Requirements *Safety of Nuclear Power Plants: Design* (IAEA Safety Standards Series No. SSR-2/1, Vienna, 2012), *Safety of Nuclear Power Plants: Commissioning and Operation* (IAEA Safety Standards Series No. SSR-2/2, Vienna, 2011) are being revised through the project DS462 that includes a number of proposal for strengthening the requirements on severe accident management.

The revision of NS-G-1.12 will also provide guidance supporting the proposed new revised requirements.

2. Taking into account the lessons learned from the accident at Fukushima Daiichi NPPs

(1) Action Plan on Nuclear Safety

After the accident at the TEPCO's Fukushima Daiichi NPPs, the IAEA Action Plan on Nuclear Safety (GOV/2011/59-GC (55)/14) includes an action to "Review and strengthen IAEA Safety Standards and improve their implementation".

This work on the lessons learned led to the decision to revise, through several addenda, SSR-2/1 and SSR-2/2 and GSR Part 4 (DS462). Since the revision of these Safety Requirements is expected to be finalised in 2014, relevant aspects should be incorporated in this Safety Guide for it to be fully up-to-date.

(2) Feedbacks on the accident in Fukushima Daiichi NPPs

Additional inputs on lessons learned from Fukushima Daiichi accident have also been provided by Consultancy Meeting for revision of NS-G-2.15 held on May 2013 for updating more information as following:

Fukushima lessons learned

(1) Accident management guidance should be developed and maintained based on the plant design, available internal and external PSA insight (if available), and current industry management guidance. Deviations from plant design requirements and industry standard accident management guidance should receive a rigorous technical and safety review that considers the basis of the original standard and the potential unintended consequences of deviating from this standard.

(2) Accident management guidance should be designed to assist emergency response personnel prioritize, monitor, and execute critical response actions in the working conditions that may exist following an extreme external event.

(3) Accident management guidelines should be developed for establishing core cooling and critical monitoring functions if DC power is lost during a prolonged loss of all AC power. These strategies should serve to prevent core damage, if possible, and to mitigate the extent of damage and reduce the potential for a large off-site release of radioactive materials.

(4) For strategies that rely on portable equipment to control key safety functions following an extended loss of all AC power, steps should be taken to ensure that personnel can install and operate the portable equipment within the time frames necessary to avoid loss of key safety functions or extend the coping time during extreme environmental and other post event conditions.

(5) Equipment required to responding a long-term loss of all AD and DC power and loss of the ultimate heat sink should be conveniently staged, protected, and maintained such it is always ready for use if needed.

(6) Procedures for venting containment should be developed assuming normal AD and DC power supplies and air systems are not functional. If rupture disks are installed in vent lines that would inhibit venting when required, a means should be established for operators to manually open the rupture disk or to establish an alternate means of venting the containment.

(7) Plans should be established for relocating personnel as well as communication and coordination functions to alternate locations should normal emergency response facilities be rendered inoperable during an event.

(8) Personnel who direct emergency response shall have the authority to take necessary actions to mitigate the event such as venting containment or injecting seawater or other water sources into the reactor without the need for external authorization. If local regulations require external authorization for such actions, actions should be taken to gain concurrence in advance on criteria for which these actions may be authorized.

(9) Personnel responsible for performing emergency response duties should be trained with the required knowledge skills, and proficiency to execute their roles.

(10) Plans for staffing emergency response positions (including control room operators, site and corporate emergency response centres) for long-duration events shall be developed, maintained, and tested. Staffing plans shall address that the event involves more than one unit at a multi-unit site.

(11) Plants should develop plans to address family/personal needs of responders who are unable to leave the site.

(12) Equipment required to responding a long-term loss of all AD and DC power and loss of the ultimate heat sink should be conveniently staged, protected, and maintained such it is always ready for use if needed.

(13) Certain key indicators of plant conditions provided erroneous information (e.g., reactor vessel water level) that led the operators to take inappropriate actions. There are two direct lessons from this:

- The operators did not use other available information to validate the information that they used to make decisions.
- The errors in the instrumentation could have been known through analysis; it should have been recognized that reference legs for level instrumentation might boil.
- There was a delay in obtaining instrument indications due to the loss of all power. Even when portable batteries were used, only key instrumentation was powered.

(12) Accident management program was developed from BWROG generic materials but there was only limited sharing of experience with usage outside of Japan. This led to inadequate guidance in certain areas such as instrumentation and command and control.

- Accident management programs should be periodically review by an international team of accident management experts and deficiencies addressed in a timely manner.
- Deviations from accepted international guidance (e.g., Owners Group SAMG) should be documented.
- The SAMG needs to reflect the current plant design and operation - as changes to plant design are made; changes to SAMG also need to be made.

(14) Emergency response relied upon offsite support but in a wide spread natural disaster, offsite support may be delayed.

- Guidance should be developed to address priorities and contingencies for offsite support.

(15) Leadership and response under extreme duress was heroic but not systematically planned in advance. Exercise and drill focus on routine emergencies rather than catastrophic emergencies where all planned resources are not available.

- Leaders need to be chosen based on ability to lead under catastrophic conditions where planned capabilities are not available.

ANNEX~~E~~ 2:

PRELIMINARY LIST OF CONTENTS