IAEA
International Atomic Energy Agency

Technical Meeting on the Safety Demonstration and Licensing of Passive Safety Features in Water Cooled Reactors

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Information Sheet

Introduction

Since the beginning of nuclear power development, the use of passive safety features, i.e. those that take advantage of natural forces such as gravity, natural convection, or accumulated internal energy, has been considered a very promising safety approach. A variety of passive features, such as reactor shutdown systems, pressurized hydro accumulators, and containment pressure suppression systems, have therefore been in use for many years. However, the use of passive safety systems for decay heat removal has not been very extensive in the past. Current and previous IAEA Safety Standards have addressed the use of a combination of inherent, passive, and active safety features, in this order of preference, in terms of their potential reliability, as inherent and passive safety features do not require human intervention or support systems.

The advantages and disadvantages of these passive features were carefully considered during the design process. Disadvantages resulting from lower driving forces in fluid systems, reduced flexibility in abnormal conditions and difficulties with the thorough demonstration of performance and reliability of

conditions with limited data and experimental or analytical verification have hindered the wide implementation of passive systems for accident conditions. In addition, the claimed economic benefits were reduced if additional active systems for start-up or shutdown were still needed or for maintaining the operability of passive systems.

With negative experiences of loss of power supplies, and advances in safety analysis methods and testing facilities for passive phenomena, a strong reliance on inherent and passive design features has become a hallmark of many advanced reactor designs, including several evolutionary designs and nearly all advanced small, medium sized and modular reactors. Passive features can be an important part of defence in depth when combined with active systems to increase diversity.

In the absence of strong active driving forces, the range of conditions to perform safety functions satisfactorily can be narrow and the reliability of passive systems is significantly influenced by changes in physical variables, equipment and environmental conditions, and interaction with other systems, among other factors. Therefore, safety demonstration is a crucial topic that cannot be approached in the same manner as for active systems; for example, it is necessary to identify and characterize the key physical phenomena that drive, govern and could impair the natural circulation to fully address the passive system's "functional behaviour". Over the years, significant efforts at the national and international level, including by the IAEA[1], have been dedicated to the safety analysis or demonstration of passive systems and the key physical phenomena characterizing their performance.

On the other hand, the regulations and requirements for nuclear power plants (NPPs) were developed at a time when active systems were predominantly used and, in most cases, do not distinguish between passive and active systems. Consequently, there are instances where regulations are not fully applicable to passive systems. Relaxation of or exemptions from the regulations have to be justified. The use of design features that are innovative or depart from well-established engineering practices needs a thorough and specific safety demonstration supported by robust validation and testing programmes.

Several water cooled reactors equipped with passive cooling systems have recently been put into operation, or are presently under commissioning, construction or development. To support the design and licensing, experimental tests have been performed to identify and characterize the thermal hydraulic phenomena and the expected system performance. In addition, the commissioning tests performed at the reactor-scale can provide complementary information on a larger, integrated scale.

Nuclear regulators worldwide are facing important challenges in the licensing of the new passive and innovative reactor designs. For this reason, a dialogue between designers, license applicants and regulators is relevant to agree on the requirements for the safety demonstration, and on the information to be submitted to a country's regulatory body. Lessons learned from the testing, analysis, and licensing of designs using passive safety features in reference plants could be useful for other designers, operators, and regulatory bodies.

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[1] The following IAEA publications, among others, address the safety of passive systems:

- INTERNATIONAL ATOMIC ENERGY AGENCY, Passive Safety Systems and Natural Circulation in Water Cooled Nuclear Power Plants, IAEA-TECDOC-1624, Vienna (2009).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Natural Circulation Phenomena and Modelling for Advanced Water Cooled Reactors, IAEA-TECDOC-1677, Vienna (2012).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Passive Safety Systems in Advanced Water Cooled Reactors (AWCRs): Case Studies, A Report of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), IAEA-TECDOC-1705, Vienna (2013).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Performance Assessment of Passive Gaseous Provisions (PGAP): Report of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), IAEA-TECDOC-1698, Vienna (2013).
- INTERNATIONAL ATOMIC ENERGY AGENCY, Progress in Methodologies for the Assessment of Passive Safety System Reliability in Advanced Reactors: Results from the Coordinated Research Project on Development of Advanced Methodologies for the Assessment of Passive Safety Systems Performance in Advanced Reactors, IAEA-TECDOC-1752, Vienna (2014).

Objectives

The purpose of the meeting is to foster the exchange of information on the latest practices and approaches to the safety demonstration of advanced water cooled NPPs, both large and small, medium sized and modular reactors, that make use of passive safety features or systems for heat removal. The meeting is intended to be a forum of discussion on several aspects that need to be considered in relation to safety demonstration and regulatory practices for passive systems, listed in the Topics Section.

Target Audience

Participation is intended for nuclear safety professionals from NPP design and operating organizations, regulatory bodies, and other technical support organizations who are engaged in activities relating to the safety of passive systems.

Designated experts should have sound knowledge and experience relating to the safety of NPPs. To ensure maximum effectiveness in the exchange of information, participants should be persons actively involved in the subject areas of the meeting.

Working Language

The working language of the meeting will be English. No interpretation will be provided.

Expected Outputs

The presentation abstracts, together with meeting discussion sessions, will enable participants to contribute to the summary report of the meeting and to make recommendations to the IAEA on future activities in this field. The IAEA will utilize the insights obtained from this Technical Meeting, together with the results of related ongoing work, to propose and develop a safety report on safety approaches for reactors with passive safety features.

Structure

The meeting will consist of presentations from the IAEA on the objectives of the meeting and ongoing work conducted by the IAEA and at the international level in relation to the safety of passive systems, and presentations by keynote speakers on specific topics relevant to the meeting objectives, followed by presentations from national and international organizations. The meeting sessions will be organized around topics of interest.

Topics

Participants are invited to share their views and experiences at the meeting and give a presentation on topics in relation to aspects of safety demonstration and regulatory practices for passive systems. Such topics may include:

- Performance demonstration;
    - Determination of operating envelopes, design performance goals;
    - Demonstration of functional behaviour;
    - Identification of phenomena or conditions leading to partial (degradation) or total failure;
- Validation and experimental programmes (e.g. test loops);
- Safety and reliability analysis, including deterministic and probabilistic treatment;
- Code development and validation needs, including those to enable uncertainty analysis;
- Regulations and regulatory practices in relation to passive systems;
- Lessons learned from the licensing or design certification of passive reactor designs, commissioning activities and operating experience feedback;
- Advanced passive systems for improved water management (e.g. dynamic passive injection system).

Participation and Registration

All persons wishing to participate in the event have to be designated by an IAEA Member State or should be members of organizations that have been invited to attend.

In order to be designated by an IAEA Member State, participants are requested to send the **Participation Form (Form A)** to their competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA or National Atomic Energy Authority) for onward transmission to the IAEA by **25 March 2019**. Participants who are members of an organization invited to attend are requested to send the **Participation Form (Form A)** through their organization to the IAEA by above deadline.

Selected participants will be informed in due course on the procedures to be followed with regard to administrative and financial matters.

Please note that the IAEA is in a transition phase to manage the entire registration process for all regular programme events electronically through the new InTouch+ (https://intouchplus.iaea.org) facility, which is the improved and expanded successor to the InTouch platform that has been used in recent years for the IAEA's technical cooperation events. Through InTouch+, prospective participants will be able to apply for events and submit all required documents online. National authorities will be able to use InTouch+ to review and approve these applications. Interested parties that would like to use this new facility should write to: InTouchPlus.Contact-Point@iaea.org.

Presentations

The IAEA encourages participants to give presentations on the work of their respective institutions that falls under the topics listed in above Topics Section.

Participants who wish to give presentations are requested to submit an abstract of their work. The abstract will be reviewed as part of the selection process for presentations. The abstract should be in A4 page format, should extend to no more than four pages, using the attached template. It should be sent electronically to all of the Scientific Secretaries of the event not later than **25 March 2019**: Mr Javier Yllera (J.Yllera@iaea.org) and Mr Matthias Krause (M.Krause@iaea.org). Authors will be notified of the acceptance of their proposed presentations by **1 April 2019**.

In addition, participants have to submit the abstract together with the **Participation Form (Form A)** to their competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA or National Atomic Energy Authority) or their organization for onward transmission to the IAEA not later than **25 March 2019.**

Expenditures and Grants

No registration fee is charged to participants.

The IAEA is generally not in a position to bear the travel and other costs of participants in the event. The IAEA has, however, limited funds at its disposal to help meet the cost of attendance of certain participants. Upon specific request, such assistance may be offered to normally one participant per country, provided that, in the IAEA's view, the participant will make an important contribution to the event.

The application for financial support should be made using the **Grant Application Form (Form C)** which has to be stamped, signed and submitted by the competent national authority to the IAEA together with the **Participation Form (Form A)** by **25 March 2019**.

Venue

The event will be held at the Vienna International Centre (VIC) where the IAEA's Headquarters are located. Participants must make their own travel and accommodation arrangements.

General information on the VIC and other practical details, such as a list of hotels offering a reduced rate for IAEA participants, are listed on the following IAEA web page:
http://www-pub.iaea.org/iaeaevents/GeneralInfo/Guide/VIC.

Participants are advised to arrive at Checkpoint 1/Gate 1 of the VIC one hour before the start of the event on the first day in order to allow for timely registration. Participants will need to present an official photo identification document in order to be admitted to the VIC premises.

Visas

Participants who require a visa to enter Austria should submit the necessary application to the nearest diplomatic or consular representative of Austria at least four weeks before they travel to Austria. Since Austria is a Schengen State, persons requiring a visa will have to apply for a Schengen visa. In States where Austria has no diplomatic mission, visas can be obtained from the consular authority of a Schengen Partner State representing Austria in the country in question.

IAEA Contacts

Scientific Secretaries

Mr Javier Yllera
Senior Safety Officer
Safety Assessment Section
Division of Nuclear Installation Safety
Department of Nuclear Safety and Security
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 VIENNA
AUSTRIA

Tel.: +43 1 2600 26109/25557
Fax: +43 1 26007
Email: J.Yllera@iaea.org

Mr Matthias Krause
Nuclear Power Technology Development Section
Division of Nuclear Installation Safety
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 VIENNA
AUSTRIA

Administrative Secretary

Ms Sanja Hadzic
Division of Nuclear Installation Safety
Department of Nuclear Safety and Security
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 VIENNA
AUSTRIA

Tel.: +43 1 2600 25557
Fax: +43 1 26007
Email: S.Hadzic@iaea.org

Subsequent correspondence on scientific matters should be sent to the Scientific Secretaries and correspondence on other matters related to the event to the Administrative Secretary.