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International Atomic Energy Agency
Agence internationale de l'énergie atomique
Международное агентство по атомной энергии
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The Secretariat of the International Atomic Energy Agency (IAEA) presents its compliments to the IAEA's Member States and has the honour to draw their attention to the **Technical Meeting on Pressurized Heavy Water Reactor Severe Accident Simulation and Modelling** (hereinafter referred to as "event") to be held virtually via Cisco Webex from **20 to 23 September 2022**.

The purpose of the event is to document best practices and understanding of severe accidents in pressurized heavy water reactors and related simulation and modelling tools.

The attached Information Sheet provides further details of the event.

The event will be held in English.

Member States are invited to designate one or more participants to represent the Government at this event. Member States are strongly encouraged to identify suitable women participants.

Designations should be submitted to the IAEA through the competent national authority (Ministry of Foreign Affairs, Permanent Mission to the IAEA or National Atomic Energy Authority) not later than **30 June 2022** using the attached Participation Form (Form A). Completed and authorized Participation Forms should be sent either by email to: Official.Mail@iaea.org or by fax to: +43 1 26007 (no hard copies needed). Copies should be sent by email to the Scientific Secretary of the event, Ms Eve-Lyne Pelletier, Division of Nuclear Power, Department of Nuclear Energy (Email: E.Pelletier@iaea.org), and to the Administrative Secretary, Ms Dorothy Kalocsai (Email: D.Kalocsai@iaea.org). The Scientific Secretary of the event will liaise with the participants directly concerning further arrangements, as appropriate, once the official designations have been received.

The IAEA takes no responsibility for, and the provider of the virtual meeting services has represented and warranted that the Services shall not contain, and that no end user shall receive from the software used to hold the virtual meeting, any virus, worm, trap door, back door, timer, clock, counter or other limiting routine, instruction or design, or other malicious, illicit or similar unrequested code, including surveillance software or routines which may, or is designed to, permit access by any person, or on its own, to erase, or otherwise harm or modify any data or any system, server, facility or other infrastructure of any end user (collectively, a "Disabling Code").

The Secretariat of the International Atomic Energy Agency avails itself of this opportunity to renew to the IAEA's Member States the assurances of its highest consideration.

2022-03-24

Enclosures: Information Sheet

Participation Form (Form A)

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Technical Meeting on Pressurized Heavy Water Reactor Severe Accident Simulation and Modelling

Virtual Event

20–23 September 2022

Ref. No.: EVT2103626

Information Sheet

Introduction

Requests for severe accident simulations and performance assurance of mitigation measures (equipment and processes) have increased for operating nuclear power plants and are now an integral part of the design of advanced nuclear power plants, including pressurized heavy water reactors (PHWR). Severe accident analysis necessitates modelling of complex and interacting physical phenomena that occur during successive stages of accident progression; thus, sophisticated computer codes are essential for integrating these complex models in a consistent way so that the integral reactor and containment responses can be predicted.

The IAEA has gained much experience over the last two years in conducting meetings remotely and will hold a Technical Meeting on *Pressurized Heavy Water Reactor Severe Accident Simulation and Modelling* virtually thus reaching out to a larger audience who will benefit from separate virtual rooms, enhanced interactive Q&A sessions and virtual tours and demos. To facilitate attendance, the meeting will be held over 4 hours each day (from 13:00 to 17:00 Vienna time) from 20 to 23 September 2022.

Historical to this activity, the IAEA initiated in 2007 a coordinated research project (CRP) that was competed in 2012 with TECDOC-1727 on Benchmarking Severe Accident Computer Codes for Heavy Water Reactor Applications (December 2013), available at: https://www-pub.iaea.org/MTCD/Publications/PDF/TE-1727_web.pdf. More recently, a 2017 Technical Meeting led to the publication of TECDOC-1872, Status and Evaluation of Severe Accident Simulation Codes for Water Cooled Reactors (June 2019), available at: https://www-

pub.iaea.org/MTCD/Publications/PDF/TE-1872web.pdf, a status report that also included codes relevant to PHWRs. However, a detailed analysis and IAEA status report for PHWR severe accident codes and test facilities for validation dates back to 2008 as described in TECDOC-1594, Analysis of Severe Accidents in Pressurized Heavy Water Reactors (June 2008), available at: https://www-pub.iaea.org/MTCD/Publications/PDF/te_1594_web.pdf.

Starting in 2017, the IAEA has organized a series of Technical Meetings addressing the status and R&D gaps in modelling and simulation of severe accidents in water cooled reactors, with tangible outputs:

- Technical Meeting on the Status and Evaluation of Severe Accident Simulation Codes for Water Cooled Reactors, Vienna, Austria, 9–12 October 2017 resulted in IAEA-TECDOC-1872 on Status and Evaluation of Severe Accident Simulation Codes for Water Cooled Reactors (June 2019)

- Technical Meeting on Hydrogen Management in Severe Accidents, Vienna, Austria, 25–28 September 2018 resulted in IAEA-TECDOC-1939 on Developments in the Analysis and Management of Combustible Gases in Severe Accident in Water Cooled Reactors Following the Fukushima Daiichi Accident (December 2020)

- Technical Meeting on the Phenomenology, Simulation and Modelling of Accidents in Spent Fuel Pools in Vienna on 2–5 September 2019 resulted in IAEA-TECDOC- Phenomenology, Simulation and Modelling of Accidents in Spent Fuel Pools – Proceedings of a Technical Meeting (April 2021)

The last in this series is this Virtual Technical Meeting on *Pressurized Heavy Water Reactor Severe Accident Simulation and Modelling*. A Consultancy Meeting held 9-11 February 2022 defined the objective and the scope, as well as topical sessions, of this Technical Meeting.

Despite significant progress in the understanding and modelling of severe accident phenomena, the implementation into integral codes remains largely empirical. Furthermore, challenging conditions in experiments make accurate and comprehensive measurements difficult, and thus result in validation data with large uncertainties. It is therefore understood that the analyses from integral severe accident codes are inherently uncertain in comparison to design basis accident analyses. Despite those uncertainties, alternate methods and checks can be applied to verify the experimental data and to quantify the analysis uncertainties. Those are to be discussed in the Technical Meeting.

The TECDOC-1727 concluded that several phases in PHWR severe accident progression, namely core disassembly, debris oxidation, and corium-vessel interaction require further research to improve the understanding and simulation of the following severe accident phenomena:

- flow area of the first fuel channel rupture,
- core collapse and disassembly modelling,
- porosity and its distribution in the debris bed,
- oxidation and hydrogen production in debris and other structural material,
- behaviour of the calandria vessel while the molten pool is formed,
- rate and species of fission product release from the terminal debris bed,
- end shield behaviour, and
- steam generation after calandria vessel failure.

These phenomena or behaviour were confirmed as requiring more research in the *Nuclear Safety Research Support Facilities for Existing and Advanced Reactors: 2021 update*, NEA No. 7565, © OECD 2021 that identified three ongoing important topics that continue to be evaluated:

- core disassembly,
- source term, and
- in-vessel retention.

Individual phenomena important to the severe accident phases have been ranked in terms of importance and knowledge level in PBNC 2012-050, Severe Accident R&D for Enhanced CANDU 6 Reactors, T. Nitheanandan, 2012, which also identifies the phenomena that need improvement in knowledge level.

In the last 10 years since the Fukushima accident, the scope for, and application of, severe accident analysis has increased in the disciplines of deterministic and probabilistic safety analysis, informing Level 2 PSA, and in support of emergency planning. In parallel, the capabilities of simulators have been extended into the severe accident domain for training and visualization.

Objectives

The overall purpose of this Technical Meeting is to share experience and transfer knowledge on recent efforts in the development, improvement, validation, and application of PHWR severe accident codes and related R&D. The meeting will also serve as a forum for Member States to identify topics where future improvements are required, and to promote collaboration on these aspects.

The meeting will have the following specific objectives, with an emphasis on achieving a better understanding of phenomena to improve modelling and code application for severe accidents in PHWRs:

- Exchange information on the advances in codes application and validation, in experimental facilities and programmes, and relevant updates in the regulatory framework;
- Discuss novel usages of severe accident modelling in simulators and under emergency situations, and of usages of Computational Fluid Dynamics (CFD) as a support tool;
- Discuss the opportunity for international cooperation and research to gain further understanding of the key phenomena or reduce their uncertainties.

The meeting will include discussion sessions to enable participants to contribute to the summary and highlights of the meeting, and to make recommendations to the IAEA on future activities in this area.

Organizing this event was strongly recommended during the 2019 meeting of the Technical Working Group on Advanced Technologies for Heavy Water Reactors (TWG-HWR).

Target Audience

Participation is intended for professionals from nuclear power plant design and operating organizations, regulatory bodies, and other technical support, research and academic organizations who are involved in severe accident analysis of current and advanced PHWRs.

Only designated participants may attend the meeting. Designated participants are expected to have knowledge or keen interest in the development, application, or validation of PHWR severe accident codes and related R&D.

Working Language(s)

The working language of the meeting will be English. All communications, presentations, and other contributions must be submitted in English.

Expected Outputs

The expected outputs of this meeting are as follows:

- Meeting report and subsequent development an IAEA publication summarizing the participants' contributions and discussions held.
- Potential initiation of IAEA led international cooperation activities.

Topics

The following list of topics focus on PHWR technologies, grouped broadly into 6 categories, and have been identified as being of potential interest to participants and suitable for consolidation in an IAEA publication, and presentations on these topics are solicited. Videos related to severe accident experiments, facilities or tours are also invited.

The topics that will form the basis of the Technical Meeting agenda will depend on submitted materials by the participants from the IAEA Member States.

1. <u>Code developments and validation in past decade</u>

- PIRT updates (re-assessment of phenomena and knowledge ranking)
- Sensitivity/uncertainty analyses or capabilities
- Code-to-code comparisons (benchmarking)
- Formal validation program implementation (e.g. V&V 2020) and user training/qualification
- CFD code validation and development of best practice guidelines
- Opportunities for international cooperation (e.g. benchmarking)

2. <u>Experiments in past decade</u>

- Identification of experimental needs/gaps and plans
- Experimental design (uncertainties, scaling, representativeness of boundary conditions and reliable high temperatures measurements)
- New facilities and programmes to address highly ranked phenomena
- Experiments to provide CFD grade data
- Opportunities for international cooperation (e.g. sharing of experimental data)

3. <u>PHWR severe accident simulators in the most recent years</u>

- Extension of full-scope simulators to DEC-A and DEC-B
- Support to SAMG and to Emergency Operation Centre (fast-running codes)
- GUI or HMI developments (video demonstrations are encouraged)
- Educational simulators (video demonstrations are encouraged)

4. <u>Updates in licensing requirements</u>

- Requirements and regulatory guidance for severe accident scope, code capabilities and code validation (including CFD)
- Development needs for more comprehensive level-2 PSA support

- Technical basis for SAMG and emergency planning

5. **CFD developments for severe accident simulation support**
- Enhanced CFD capabilities to substitute experiments
- CFD to quantify and reduce uncertainties in empirical correlations
- CFD for improving phenomenological understanding
- CFD to address specific geometric effects and to inform lumped-parameter severe accident codes

This meeting may also include break-out sessions on the following topics:

- Demonstration of IAEA Advanced PWR severe accident educational simulator
- Severe accident experiments or facilities videos
- Virtual tour(s)

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 **30 June 2022**. 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 matters.

Participants are hereby informed that the personal data they submit will be processed in line with the Agency's Personal Data and Privacy Policy and is collected solely for the purpose(s) of reviewing and assessing the application and to complete logistical arrangements where required.

Papers and Presentations

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

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 4 pages (including figures and tables) and should not exceed 2000 words. The abstract and presentation should be sent electronically to Ms Eve-Lyne Pelletier, the Scientific Secretary of the event (see contact details below), not later than **30 June 2022**. Authors will be notified of the acceptance of their proposed presentations by **15 August 2022**.

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 **30 June 2022.**

Important: Contributors of material to be included in the meeting proceedings are required to assign all copyrights or rights to publish to the IAEA. The authors should make sure that the files do not include copyrighted figures or other impediments for reproduction.

IAEA Contacts

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

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Participation Form

Technical Meeting on Pressurized Heavy Water Reactor Severe Accident Simulation and Modelling

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To be completed by the participant and sent to the competent national authority (e.g. Ministry of Foreign Affairs, Permanent Mission to the IAEA, or National Atomic Energy Authority) of his/her country for subsequent transmission to the International Atomic Energy Agency (IAEA) either by email to: Official.Mail@iaea.org or by fax to: +43 1 26007 (no hard copies needed). Please also send a copy by email to the Scientific Secretary E.Pelletier@iaea.org and to the Administrative Secretary D.Kalocsai@iaea.org.

Deadline for receipt by IAEA through official channels: 30 June 2022

Family name(s): (same as in passport)	First name(s): (same as in passport)	Mr/Ms
Institution:		
Full address:		
Tel. (Fax):		
Email:		
Nationality:	Representing following Member State/non-Member State/entity or invited organization:	
If/as applicable: Do you intend to submit a paper? Yes ☐ No ☐ Would you prefer to present your paper as a poster? Yes ☐ No ☐ Title:		

Participants are hereby informed that the personal data they submit will be processed in line with the Agency's Personal Data and Privacy Policy and is collected solely for the purpose(s) of reviewing and assessing the application and to complete logistical arrangements where required.