Sixth Joint IAEA–GIF Technical Meeting/Workshop on the Safety of Sodium Cooled Fast Reactors

IAEA Headquarters
Vienna, Austria

Vienna International Centre
Meeting Room VIC C0343, C Building

14–15 November 2016

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Terms of Reference

A. Background

Sodium cooled fast reactors (SFRs) have reached in nearly seven decades of development a high level of maturity through the design, construction and operation of experimental and prototype reactors, such as the experimental reactor EBR-II and the Fast Flux Test Facility in the United States of America; the small size Prototype Fast Reactor in the United Kingdom; the prototype Phénix reactor in France; the BN-350 reactor in Kazakhstan; the research reactors BOR-10 and BOR-60 and the demonstration reactor BN-600 followed by the evolutionary BN-800 reactor in the Russian Federation; the JOYO and MONJU reactors in Japan; the commercial size Superphénix reactor in France; and the Fast Breeder Test Reactor in India.

Several countries are currently engaged in SFR design and construction projects. In China, the 65 MW(th) (20 MW(e)) China Experimental Fast Reactor reached criticality for the first time on 25 July 2010 and was connected to the grid on 21 July 2011. The commercialization of fast reactors in China will follow with the realization of the demonstration plant CFR-600 expected to be developed also thanks to international collaboration. In India, the construction of the 500 MW(e) Prototype Fast Breeder Reactor (PFBR) at Kalpakkam is expected to be completed this year. Taking advantage of the feedback and experience gained from the design, construction and safety review of the PFBR, the Indian programme for fast reactor deployment foresees the construction of the FBR-1 and 2 units around 2023–2024, and the development and deployment of future fast breeder reactors with metallic fuel and higher breeding ratios beyond 2025. In the Russian Federation, which has been operating in Beloyarsk the commercial demonstration fast reactor BN-600 since 1980, the currently most powerful fast reactor, the BN-800, was connected to the grid in December 2015. The Russian Federation has also launched the Federal Target Programme "New Generation Nuclear Power Technologies for 2010-2015 with Outlook to 2020", aimed, in particular, at the development of the BN-1200 reactor (an advanced SFR), as well as the new multipurpose SFR called MBIR ('Multipurpose Fast Research Reactor'). In 2010, under the European Strategic Energy Technology Plan, the European Union has defined the technological pathway for developing fast neutron reactors, which includes the SFR concept as a first track aligned with Europe's prior experience. The related demonstration and implementation programme ESNII ('European Sustainable Nuclear Industrial Initiative') foresees the realization in France of the Generation IV SFR prototype called ASTRID ('Advanced Sodium Technological Reactor for Industrial Demonstration'). Japan has been developing the 1500 MW(e) GenerationIV JSFR ('Japan sodium cooled fast reactor') within the framework of its Fast Reactor Cycle Technology (FaCT)Development project; in parallel Toshiba is conducting the detailed design and the safety analysis of its small-size 4S ('Super-Safe, Small and Simple') concept. The Republic of Korea is carrying out a broad research and development programme in support of the development of the Prototype Generation IV Sodium Cooled Fast Reactor. Finally, in the USA, GE Hitachi Nuclear Energy is continuing the development of its 311 MW(e) modular SFR called PRISM ('Power Reactor Innovative Small Module'), TerraPower is developing a Travelling Wave Reactor-Prototype (TWR-P) cooled by sodium, and the company Advanced Reactor Concepts (ARC) is pursuing development of a 100 MW(e) design (ARC-100) for potential initial deployment in Canada.

Besides the above-mentioned national and commercial design projects, relevant international initiatives have been established in the last years in order to promote cooperation among countries with innovative SFR development and deployment programmes. The most relevant are the ones carried out under the auspices of the Generation IV International Forum (GIF) and the International Atomic Energy Agency (IAEA), which have jointly committed to collaboration between the programmes and to share information in selected areas of mutual interest. One of the key areas of emphasis in both the GIF and the IAEA programmes is the safety of SFRs and, in particular, the harmonization of safety approaches, safety requirements, safety design driteria (SDC) and safety design guidelines (SDG) for the next generation SFRs under development worldwide. This topic has gained in importance in the aftermath of the accident that occurred in 2011 at the Fukushima Daiichi

NPP, which drew renewed attention to nuclear safety and to the importance of an international safety framework for reactors currently in operation as well as for new designs.

Within the framework of this collaboration, a series of joint IAEA–GIF workshops on the safety of SFRs have been held since 2010. The first such workshop, which had the theme: "Operational and Safety Aspects of Sodium Cooled Fast Reactors" was held from 23 to 25 June 2010 at the IAEA's Headquarters in Vienna, Austria. This was followed by a second workshop themed "Safety Aspects of Sodium Cooled Fast Reactors", held from 30 November to 1 December 2011, also in Vienna.

The third joint IAEA–GIF workshop, with the theme "Safety Design Criteria for Sodium Cooled Fast Reactors", was held in Vienna from 26 to 27 February 2013. The outcomes of this workshop were discussed also during the International Conference on Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13), held in Paris, France, from 4 to 7 March 2013, which included a specific track on "Fast Reactor Safety: Post-Fukushima Lessons and Goals for Next-Generation Reactors" and a panel session on "Safety Design Criteria".

The development of the Safety Design Criteria was initiated by the GIF Policy Group (PG) in 2011 in order to harmonize safety requirements among the design organizations represented within GIF, and to quantify the high level of safety expected for Generation IV systems. The Safety Design Criteria, derived from the Generation IV programme goals and developed consistently with the structure of the IAEA safety standards, have been compiled into a Phase 1 report first presented and discussed at the above-mentioned joint IAEA–GIF workshop in February 2013, and then issued by the GIF in May 2013.

The GIF Policy Group, in July 2013, decided to invite regulators from GIF member countries and some international organizations (the IAEA, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD/NEA), and the Multinational Design Evaluation Programme) to review the Phase 1 report, and to proceed with Phase 2 work intended to, firstly, quantify the Safety Design Criteria for SFRs and, secondly, to develop detailed Safety Design Guidelines to implement the general criteria. In the same time frame, the GIF and the IAEA have agreed to invite design organizations currently developing innovative SFRs, with the aim of presenting engineering solutions able to meet the Safety Design Criteria.

As a consequence, the fourth joint IAEA–GIF workshop in the series, which was themed "Safety Design Criteria for Sodium Cooled Fast Reactors" and took place in Vienna from 10 to 11 June 2014, focused on: (i) the status of the review of the Safety Design Criteria Phase 1 report by Regulators and international organizations; (ii) the implementation of current Safety Design Criteria by the designers of innovative SFR concepts, i.e. the China Institute of Atomic Energy, the French Alternative Energies and Atomic Energy Commission, AREVA, Électricité de France, the Indira Gandhi Centre for Atomic Research, Bharatiya Nabhikiya Vidyut Nigam Limited, the Japan Atomic Energy Agency, the Korea Atomic Energy Research Institute, the Afrikantov Experimental Design Bureau for Mechanical Engineering, Oak Ridge National Laboratory, General Electric; and (iii) examples of implementation of specific Safety Design Criteria, i.e. practical elimination of accident situations, design extension conditions, sodium void reactivity effect. A status report on the development of the Safety Design Guidelines was also presented by the Chair of the GIF Task Force on SFR Safety Design Criteria.

Continuing these efforts, at the fifth joint IAEA–GIF workshop on the safety of SFRs (Vienna, 23-24 June 2015) there were constructive discussions on the updated Safety Design Criteria and Safety Design Guidelines for SFRs and on related activities. The participants in this workshop were also updated on the status of the international review of the Safety Design Criteria Phase I report and of the Phase II development of Safety Design Guidelines. Responses from the United States Nuclear Regulatory Commission, the IAEA's comments on the Safety Design Criteria Phase I report, and the comments by France's Institute for Radiological Protection and Nuclear Safety on GIF report SDC-TF/2013/1 were also examined. The GIF report entitled *Safety Design Guidelines on Safety*

Approach and Design Conditions for Generation IV SFR Systems was reviewed and discussed and the status was updated.

A letter from the GIF Task Force on SFR Safety Design Criteria was received by the IAEA in April 2016. In this letter it was noted that early engagement with regulatory organizations on the proposed Safety Design Guidelines might reduce licensing uncertainties and promote safety. Therefore, the GIF Task Force on SFR Safety Design Criteria is inviting GIF member countries as well as international bodies, such as the IAEA and the OECD/NEA Joint CNRA–CSNI Ad-hoc Group on the Safety of Advanced Reactors, to review the report on Safety Design Guidelines for safety approaches. The sixth joint IAEA–GIF workshop on the safety of SFRs will discuss this report on Safety Design Guidelines for safety approaches. An update on the status of the ongoing efforts by the GIF Task Force on SFR Safety Design Criteria to develop the report on Safety Design Guidelines for structures, systems and components will also be provided.

In order to continue in-depth discussions on the development of SFR Safety Design Criteria and Safety Design Guidelines, and in accordance with the recommendations of the Tenth GIF–IAEA Interface Meeting (Vienna, Austria, 11–12 April 2016), the sixth joint IAEA–GIF workshop on the safety of SFRs is being organized by the IAEA and is planned to be held in Vienna, Austria, from 14 to 15 November 2016.

B. Purpose

The purpose of the meeting/workshop is to:

- Review and discuss the GIF report entitled *Safety Design Guidelines on Safety Approach and Design Conditions for Generation IV SFR Systems*;
- Share information on the implementation of the Safety Design Guidelines for SFRs by the designers of innovative SFR concepts;
- Discuss the GIF's response to the regulators' comments on the GIF report on Safety Design Criteria for SFRs, and review the updated report; and
- Discuss the development of the draft GIF report on Safety Design Guidelines for key structures, systems and components.

C. Target Audience

The target audience for this meeting/workshop comprises:

- Representatives of GIF member countries that are signatories to the system arrangement for the SFR system;
- GIF Technical Director, representatives of the GIF Task Force on SFR Safety Design Criteria, and other SFR safety experts;
- Representatives of research and design organizations working on innovative SFR designs that are currently under development; and
- Representatives of regulatory bodies and technical and scientific support organizations (TSOs). GIF will provide a final list of participants from their side, including the representatives of SFR designers and regulatory bodies/TSOs.

The group of IAEA participants may include (but is not limited to) staff from the following Departments:

- Department of Nuclear Energy
- Department of Nuclear Safety and Security

D. Venue

The meeting/workshop will be held at the IAEA's Headquarters in Vienna, Austria, specifically in Meeting Room VIC C0343, C Building, of the Vienna International Centre (5 Wagramer Straße, 1400 Vienna, Austria).

E. IAEA Secretariat

Scientific Secretaries

Mr Vladimir Kriventsev
Fast Reactor Development Team
Nuclear Power Technology Development Section
Division of Nuclear Power
Department of Nuclear Energy
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 VIENNA
AUSTRIA
Tel.: +43 1 2600 22808
Email: V.Kriventsev@iaea.org

Mr Javier Yllera
Senior Nuclear 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
Email: J.Yllera@iaea.org

Administrative Secretary:

Ms Jasna Šegota
Nuclear Power Technology Development Section
Division of Nuclear Power
Department of Nuclear Energy
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 VIENNA
AUSTRIA
Tel.: +43 1 2600 24236
Email: J.Segota@iaea.org

Official correspondence on scientific matters should be sent to the Scientific Secretaries and correspondence on other matters related to the meeting/workshop to the Administrative Secretary.