Chapter 6. **Task Force Reports**

ETTF: Education & Training Task Force

Background/term of reference

The GIF Education and Training Task Force (ETTF) was launched in 2015 to serve as a platform to enhance open Education and Training (E&T), as well as communication and networking of people and organizations in support of Gen-IV International Forum. The principal objective of the task force is focused on promoting E&T by:

1) identifying and advertising current training courses;
2) identifying and engaging collaboration with other international E&T organizations;
3) developing webinar series dedicated to Gen-IV systems and related cross-cutting topics and advertising these at the national and international level;
4) creating and maintaining a modern social medium platform (LinkedIn www.linkedin.com/groups/8416234) to exchange information and ideas on GIF Research and Development (R&D) topics, as well as related GIF E&T activities.

Main achievements in 2019

The development of webinars is a one of the main activities of this task force. It is intended to inform and stimulate not only young scientists' interest, but also managers, key decision makers and the general public; about advanced reactors introducing foreseen advantages but also key R&D to be developed, knowledge management and preservation with lessons learnt, current research and existing projects.

The ETTF has established collaborative associations with universities and nuclear organizations (**Table ETTF 1**) actively involved in Gen-IV systems to foster the exchange of scientific and technical information for the development of webinars.

Table ETTF 1. **Organizations involved with the development of GIF webinars**

US Department of Energy – Office of Nuclear Energy, United States	Université de Lille 1, France
Institute of Energy and Environment, Youngsan University, Korea	Paul Scherrer Institute, Switzerland
Commissariat à l'Energie Atomique et aux Energies Alternatives, France	Euratom, EU
Argonne National Laboratory, United States	Institute of Physics and Power Engineering, Russia
Canadian Nuclear Laboratories, Canada	Ansaldo Nucleare, Italy
University of California, Berkeley, United States	Kurchatov Institute, Russia
US Naval Postgraduate School, United States	Brookhaven National Laboratory, United States
Nuclear Energy Agency	SCK.CEN, Belgium
Idaho National Laboratory, United States	Los Alamos National Laboratory, United States
Nuclear National Laboratory, United Kingdom	INET, Tsinghua University, China
Research Center Řež, Czech Republic	Japan Atomic Energy Agency, Japan
National Research Nuclear University "MEPhI", Russia	Idaho State University, United States
Colorado School of Mines, United States	Oak Ridge National Laboratory, United States

Because of its easy access, and free of charge, the ETTF has decided to present webinars and exploits this modern internet technology to reach interest of a broader audience. Therefore, to promote training in Gen-IV systems and to ensure a knowledgeable workforce exists, were created and made them available to the public since 2016 a series of webinars on topics specific to advanced reactor systems and cross-cutting subjects. These webinars are intended to be of interest to those already in the workforce who may need a refresher course or a better understanding of a specific topic, to a more general public. World-class webinars presented by Gen-IV Experts (usually GIF members) will be useful to a wide scope of people (like quality assurance officers, data validators, technicians, managers, regulators, and others who require an enhanced understanding of Gen-IV reactor concepts in their work). Thirty-six webinars have been developed, recorded and archived on the GIF Open Website. It is worth to note that during the GIF Symposium (October 2018 in Paris), an elevator pitch challenge (EPiC) contest was organized and the three best students winning this contest were offered to give a webinar presentation (**Table ETTF 2**). During the American Nuclear Society winter meeting (Washington DC, November 2019), a similar event, called "Pitch your PhD" was organized. The winner Dr Coddy Wiggins will present a webinar titled "*Development of Multiple-Particle Positron Emission Particle Tracking for Flow Measurement*", in Dec. 2020.

Table ETTF 2. **GIF Webinar Series (September 2016 to December 2019)**

INTRODUCTION
Atoms for Peace - John Kelly, USA
Introduction to Nuclear Reactor Design - Claude Reanult, France
European Sodium Fast Reactor, An Introduction - Konstantin Mikityuk, Switzerland
GEN IV SYSTEMS
Sodium cooled Fast Reactor - Bob Hill, USA
Lead Fast Reactor - Craig Smith, USA
Gas cooled Fast Reactor, Alfredo Vassile, France
MYRRHA An Accelerator driven System Based on LFR Technology - Hamid Ait Abderrahim, Belgium
Lead Containing mainly isotope Pb-208: New Reflector for Improving Safety of Fast Neutron Reactors - Evgeny Kulikov, Russia
Very High Temperature Reactors - Carl Sink, USA
Supercritical Water Reactors - Lawrence Leung, Canada
Fluoride cooled-High Temperature Reactors - Per Peterson, USA
Molten Salt Reactors - Elsa Merle, USA
Gen IV Coolants Quality Control - Christian Latge, France
Czech Experimental Program on MSR Technology Development, Jan Uhlir, Czech Republic
OPERATIONAL EXPERIENCE
Desig, Safety Features and Progress of HTR-PM - Yujie Dong, China
Feedback Phenix and Superphenix - Joel Guidez, France
Molten Salt Actinide Recycler & Transforming System with and without Th-U Support: MOSART - Victor Ignatiev, Russia
Astrid Lessons Learned - Gilles Rodriguez, France
Safety Of Gen IV Reactors - Luca Ammirabile, EC
Advanced Lead Fast Reactor European Demonstrator, ALFRED Project - Alessandro Alemberti, EC
Russia BN 600 & BN 800 - Ilya Pakhomov, Russia
The ALLEGRO Experimental Gas Cooled Fast Reactor Project - Ladislav Belovsky, Czech Republic
GEN IV CROSS CUTTING TOPICS
Energy Conversion, Richard Stainsby, United Kingdom
Estimating Costs of Gen IV Systems - Geoffrey Rothwell, NEA/OECD
Materials Challenges for Gen IV Reactors - Stu Maloy, USA
FUEL TYPES
General Consideration on Thorium as a Nuclear Fuel - Franco Michel-Sendis, NEA/OECD
Metallic Fuels for SFRs - Steven Hayes, USA
Advanced Gas Reactor TRISO Particle Fuel - Madeline Feltus, USA
SUSTAINABILITY AND FUEL CYCLE
Closing the Fuel Cycle, Myeung Seung, Republic of Korea
Sustainability, A Relevant Approach for Defining Future Nuclear Fuel Cycles - Christophe Poinssot, France
Scientific and Technical Problems of Closed Nuclear Fuel in Two-Components Nuclear Energetics - Alexander Orlov, Russia
Winners of the Elevator Pitch Challenge (EPiC) contest at the GIF Symposium, Paris, October 2018
Formulation of Alternative Cement Matrix For Solidification/Stabilization of Nuclear Waste - Matthieu de Campos, France
Interactions between Sodium and Fission Products in case of a severe Accident in a Sodium-cooled Fast Reactor - Guilhem Kauric, France
Security Study of Sodium Gas Heat Exchangers in Frame of Sodium-Cooled Fast Reactors - Fang Chen, France

The webinars are already planned from January 2020 to June 2020, as shown in **Table ETTF 3**.

Table ETTF 3. **GIF Webinar Planned until June 2020**

Webinars Planned from January 2020 to December 2020
Thermal-hydraulics in Liquid Metal Fast Reactors, Antoine Gerschenfeld, CEA, France – January 2020
SFR Safety Design Criteria (SDC) and Safety Design Guidelines (SDGs), Shigenobu Kubo, JAEA, Japan, February 2020
MicroReactors: A Technology Option for Accelerated Innovation, Jee Gehin (INL and DV Rao LANL), United States, March 2020
GIF VHTR Hydrogen Production Project Management Board, Sam Suppiah, CNL, Canada, April 2020
Performance Assessments for Fuels and Materials for Advanced Nuclear Reactors, Daniel LaBrier, ISU, United States
Comparison of 16 Reactors Neutronic Performance in Closed Th-U and U-Pu cycles, Jiri Krepel, PSI, Switzerland, June 2020

As of August 2019, attendance during the live webcasts totals 1906 and the number of viewings of recorded webinars in the online archive is 3 332 for a total of webinar viewing of 5 238 in 3 years.

The participants in the GIF webinars include representatives from multiple organizations such as federal agencies, national laboratories, various state agencies, universities, international organizations, contractors, and commercial organizations. **Figure ETTF 1** represents the GIF webinar attendance distribution for 35 webinars presented. It is important to note that 35% of webinar attendees are from international organizations. Representatives from state agencies comprise the largest single organization type.

Figure ETTF 1. **Organization type for 35 webinars as of December 2019**

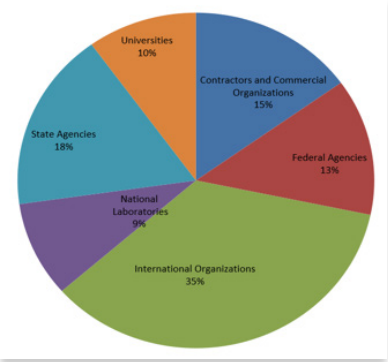

Figure ETTF.2. **Molten Salt Bootcamp, 1-3 July 2019**

The GIF ETTF was represented by Prof. M. Fratoni, from UC Berkeley who participated in the "Molten Salt Summer Boot Camp", 1-3 July 2019, TU Delft, Netherlands.

A paper summarizing the ETTF's activities and titled: "The GIF Webinars, Past, Present and Future" was presented at the international conference Global 2019, September 2019, Seattle. During this conference, Prof. Il Soon Hwang and Dr Patricia Paviet were representing the GIF ETTF at a panel session "Building Next Generation Nuclear: Enabling Succession Planning to Create and Maintain a Well Educated Worksfoce in the Nuclear Energy Sector". This panel addressed some of the key challenges for the nuclear energy sector with respect to maintaining and growing a healthy and diverse talent pipeline of higher-level skills and subject matter experts to drive future thought leadership in fuel cycle.

Due to these excellent results proving the viability and dynamism of this Task Force (see **Figure ETTF 3**), it was decided during the GIF Policy Group meeting in Oct. 2019 to transform this Task Force to a Working Group. The E&T Task Force (ETTF) will therefore move to the E&T Working Group (ETWG). Thanks to this it will start to think deeper – in addition with the webinars series – to some medium-term/long-term actions. Therefore the 1st Face to Face ETWG will occur in 2020 the discuss and propose a common GIF Education & Training vision.

Figure ETTF 3. **The 1st ETTF Selfie event during the Webinar Presentation of Fang Chen who was one of the three "best students winning contest" of the GIF Symposium**

Patricia Paviet

Chair of the ETTF and all Contributors

SDC-TF: Safety Design Criteria Task Force

In 2018 and 2019, the GIF SFR Safety Design Criteria Task Force (SDC-TF) completed the first draft of the SFR Safety Design Guidelines report "Safety Design Guidelines on Structures, Systems and Components for Generation IV Sodium-cooled Fast Reactor Systems" (SSC SDG), which is the second guideline, and revised the "Guidelines on Safety Approach and Design Conditions of Generation IV SFR Systems" (SA SDG), which is the first guideline, by reflecting external feedback from OECD/NEA Working Group on the Safety of Advanced Reactors (WGSAR) and the IAEA.

The SDC-TF completed the SFR Safety Design Criteria (SDC) report in 2013 as the outcome of its phase I activities, distributed it to international organizations (IAEA, MDEP, NEA/CNRA, and regulatory bodies of the GIF member states with active SFR development programmes, namely, China, EC, France, Japan, Korea, Russia and the United States), and revised it on the basis of their comments. To revise it, the SDC-TF adopted many technical descriptions of the IAEA SSR 2/1 revision 1 issued in 2016, including new provisions that reflect lessons learnt from the TEPCO's Fukushima Daiichi nuclear power plants accident. It published the revised SFR SDC report in 2017 after the GIF Experts Group (EG) and Policy Group (PG) have approved it.

The SDC-TF has prepared the SFR safety design guidelines as a set of recommendations on how to meet the SDC and address SFR-specific safety issues. The purpose of the SA SDG is to facilitate the practical application of the SDC to Generation IV SFR design tracks by clarifying technical issues and providing recommendations with a variety of design options. It describes prevention and mitigation of severe accidents, situations that should be practically eliminated (e.g. issues related to the loss of heat removal), and considerations for SFR reactivity characteristics. The SDC-TF distributed the SA SDG to the NEA GSAR (the predecessor of NEA WGSAR) and the IAEA to receive external review. The SDC-TF integrated solutions to IAEA's 23 comments and WGSAR's 128 comments into the revised SA SDG report and sent the revised version to the GIF EG members in 2019 to invite their comment.

The purpose of the SSC SDG is to guide and support SFR designers when practically applying the SDC in design process so that their design can ensure the highest level of safety. The SSC SDG builds bridges between the recommendations of the SA SDG and each SSC design. In addition, the SSC SDG describes recommendations to meet the requirements of the SDC Report which are not covered in the SA SDG. The recommendations in the SSC SDG include measures considering SFR's reactivity characteristics against Anticipated Transient Without Scram (ATWS), and the measures to practically eliminate the core uncovering and the complete loss of decay heat removal function. The recommendations which are not covered in the SA SDG are on fuels and materials under high-temperature, radiation conditions and on measures against various hazards such as sodium fire, sodium-water reaction, and load factors on the containment system, for example **Figure SDCTF 1** shows the consideration process towards the SSC SDG development. The SSC SDG describes the three fundamental safety systems: the core system, the coolant system, and the containment system, which particularly includes selected 14 focal points regarding the SFR-specific safety features as listed in **Table SDCTF 1**. The SDC-TF referred to design features of Generation IV SFR systems, and the descriptions, definitions, and formats of IAEA NS-G series to develop the recommendations. Although the current SSC SDG primarily covers the main components, it will also address other SSCs such as fuel handling and fuel storage systems. The SDC-TF distributed the SSC SDG in 2019 to OECD/NEA WGSAR and IAEA Department of Nuclear Energy to receive external review.

For the next generation advanced LMFRs under development worldwide, GIF and IAEA have a mutual interest in harmonizing safety approaches, safety requirements, the SDC, and the SDGs. This has become a significant topic especially after the TEPCO's accident in 2011, which caused increased attention to nuclear safety and importance of international frameworks for existing reactors currently in operation and for reactors with new designs. In a framework of GIF-IAEA collaboration, there have been eight joint IAEA-GIF technical meetings on SFR safety since 2010. The SSC SDG was introduced in the eighth IAEA-GIF workshop in Vienna in March, 2019.

Figure SDCTF 1. **Consideration process of the SSC SDG**

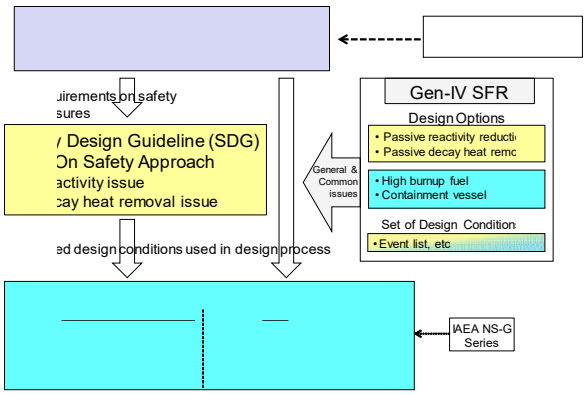

Table SDCTF 1. **SFR-specific safety features**

Systems	Safety features	Focal points	SDC	SDG on Safety Approach
Reactor Core systems	Integrity maintenance of core fuels	1. Fuel design to withstand high temperature, high inner pressure, and high radiation conditions	✓	
		2. Core design to keep the core coolability	✓	✓
	Reactivity control	3. Active reactor shutdown	✓	✓
		4. Reactor shutdown using inherent reactivity feedback and passive reactivity reduction	✓	✓
		5. Prevention of significant energy release during a core damage accident, In-Vessel Retention	✓	✓
Coolant systems	Integrity maintenance of components	6. Component design to withstand high temperature and low pressure conditions	✓	
	Primary coolant system	7. Cover gas and its boundary	✓	
		8. Measures to keep the reactor level	✓	✓
	Measures against chemical reactions of sodium	9. Measures against sodium leakage	✓	
		10. Measures against sodium-water reaction	✓	
	Decay heat removal	11. Application of natural circulation of sodium	✓	✓
		12. Reliability maintenance (diversity and redundancy)	✓	✓
Containment systems	Design concept and load factors	13. Formation of containment boundary and loads on it	✓	
	Containment boundary	14. Containment function of secondary coolant system	✓	

The SDC-TF has produced the SFR safety documents listed below and successfully completed most of its missions: (These are currently being reviewed)

- Safety Design Criteria for Generation IV Sodium-cooled Fast Reactor System.
- Safety Design Guidelines on Safety Approach and Design Conditions for Generation IV Sodium-cooled Fast Reactor Systems.
- Safety Design Guidelines on Structures, Systems and Components for Generation IV Sodium-cooled Fast Reactor Systems.

To discuss remaining topics, SDC-TF members proposed to the GIF PG that the SDC-TF joins the RSWG on the GIF PG meeting (Oct. 2019, Weihai, China), and the PG approved it; the SDC-TF members will join the RSWG as new members from the RSWG meeting in April 2020.

Shigenobu Kubo

Chair of the SDC-TF and all Contributors

AMME TF: Advanced Manufacturing and Material Engineering Task Force

Background

Deployment of future Generation IV reactors will require the successful utilization of both traditional Nuclear Structural Materials and improved material designs and utilize modern advanced manufacturing techniques where they can reduce cost or time. However, most nuclear design codes utilize design by rule philosophies that typically dictate that only qualified materials and processes can be used. Getting new materials or new manufacturing processes qualified can be a long and tortuous process and the long lead times involved produce an effective and consequent barrier to market entry of new or optimized materials and processes at an industrial scale.

Collectively, these issues present a barrier to market entry for Generation IV reactors and the development of materials and manufacturing solutions to benefit the six Generation IV reactor systems. Furthermore, developments in advanced manufacturing are occurring much faster than our ability to introduce new materials and methods into design codes potentially stifling innovation and hampering deployment. The GIF Advanced Manufacturing Materials Engineering Task Force was formed to investigate how collaborative R&D could be used to enable such advances to reduce the time to deployment of Gen-IV and comparable advanced reactors.

The initial primary aims of the Task Force were to undertake a feasibility assessment for a GIF cross-cutting activity in Advanced Manufacturing and Materials Engineering by.

- Assessing the interest of both research institutions and nuclear companies within GIF countries in a cross-cutting activity in GIF supporting Advanced Materials and Manufacturing solutions to a High Technology Readiness Level (TRL).
- Developing and applying a flexible and accessible approach with clearly identified mechanisms for directly involving leading and SME advanced nuclear reactor companies from GIF countries.
- Developing a priority list of R&D areas and initiatives.
- Delivering a white paper discussing the identifying merits and difficulties of such co-operation on this topic and identifying potential ways forward.

Operation

The Task Force consists of members from the GIF countries. Its initial activities focused on identifying mechanisms to reach out to relevant personnel in the nuclear industry. Consequently, the following hypothesis was developed designed to be tested through the use of a questionnaire:

"*That the development of advanced reactor systems to provide clean energy around the world can benefit from international collaborations in the development of advanced manufacturing technologies and techniques.*"

A survey was developed using Survey Monkey (www.surveymonkey.com) to obtain data to test the hypothesis. The survey was sent to over 200 relevant nuclear industry contacts, which were identified using input from Task Force, Expert Group and Steering Committee representatives.

The individuals represented the following stakeholder groups:

- Designers and developers of advanced reactor technologies;
- Research institutions and national laboratories;
- University nuclear research departments;
- Safety authorities;
- Manufacturers and suppliers to the nuclear industry;
- Codes and standards organization;
- Nuclear industry policy and trade associations.

There were just under 50 replies. Although it was possible to complete the survey anonymously almost all respondents volunteered contact information to facilitate follow-up. This data showed that the respondent breakdown was:

- 46% research institutions and national laboratories;
- 33% designers and developers of advanced reactor technologies;
- 15% manufacturers and suppliers to the nuclear industry;
- 8% university nuclear research departments;
- 5% nuclear industry policy and trade associations;
- 3% codes and standards organization.

Encouragingly responses came from ten GIF member countries:

Considering the survey as a whole, a number of clear messages emerged. There was strong support for collaborating on establishing codes and achieving regulatory acceptance. 90% of respondents see approval by codes and standards organizations as the largest obstacle to the adoption of Advanced Manufacturing. There was also a clear preference on how to best work collaboratively to address this problem with interest across the board (87%) in participating in workshops and conferences. There was also substantial interest (59%) in pursuing collaborative research and development opportunities but this is balanced by relatively low interest (26%) in investing in advanced manufacturing at this time. In this context, respondents' interests aligned with orientation of their organization, e.g. Universities supported further R&D but did not, in the main want to invest.

Responses to specific questions about areas of interest and priorities provided important insights into the needs and interests of the community. In response to a question asking what type of components are of the greatest interest then fuel cladding, fuel assemblies, reactor internals and heat transfer systems (e.g. IHX, steam generator tubes etc.) were gained equal support with a substantial but lesser interest in reactor pressure vessels. When asked what Advanced Manufacturing techniques hold the greatest potential value, the highest support was for cladding, coating and surface modification techniques with good support for both improvements to welding & joining and metal additive manufacturing and also support for post-manufacturing treatment techniques and new approaches to construction. Indeed, virtually all advanced manufacturing methods were considered opportunities with only 21 out of 143 individual assessments of the techniques listed ascribing them "Low" or "Very Low" value.

As noted earlier, when asked what are the greatest obstacles for the adoption of Advanced Manufacturing approval by code and regulatory bodies was cited by 90% or respondents. Other main concerns centred around uncertainties about the quality and/or maturity of Advanced Manufacturing technologies. Interestingly cost was only seen as a moderate issue indicating the increasing interest in the community in alternatives to the conventional nuclear supply chain.

Clear consensus also emerged when asked what the best pathway for gaining international acceptance for Advanced Manufacturing. Given that the major obstacle was seen as acceptance by regulatory bodies, it is not surprising that by far the greatest support was for collaboration on testing and materials performance combined with demonstrations in real world applications. This was followed by collaboration on codes and standards and Advanced Manufacturing R&D.

As may be expected, collaborations on codes and standards was rated the highest by manufacturers, codes and standards organizations, and industry associations while collaboration on R&D was rated the highest by research entities and national laboratories. Importantly, demonstration in real world applications was supported by all stakeholders; and particularly by codes and standards organizations.

Conclusions (or next steps)

The results from the survey showed that there was a very real interest in both research institutions and nuclear companies within GIF countries in active collaboration supporting Advanced Materials and Manufacturing solutions to a High Technology Readiness Level (TRL).

Consequently, the AMME Task Force prioritized its activities and concentrated on the provision of an international workshop designed to investigate how collaborative R&D in the file of advanced manufacturing can be used to reduce the time to deployment of advanced reactor systems.

Advantage was taken to combine the AMME Task Force Advanced Manufacturing Workshop with another GIF workshop being organized by the GIF RDTF allowing both workshops to be held on 18-20 February 2020 at the NEA in Paris. The structure of the AMME workshop is given below:

Tuesday 18 February	GIF AMME Workshop on Advanced Manufacturing **DAY 1**
0900 - 0910	**Welcome and opening remarks** Sama Bilbao y Leon
Session 1 – Overview of workshop	
09:10 - 09:30	Introduction on the opportunities and challenges of advanced manufacturing, overview of AMME Task Force, purpose of workshop: Why we are here! *Lyndon Edwards, ANSTO, Australia*
09:30 - 10:00	The nuclear supply chain; past, present and future *Andrew Storer, NAMRC, UK* (20mins+10 min discussion)
10:00 – 10.30	Morning Tea
Session 2 – Advanced Manufacturing Technologies	
10:30 - 11:00	Additive manufacturing in the nuclear supply chain *Kurt Terrani, ORNL, United States* (20mins+10 min discussion)
11:00 – 11:30	Innovative fabrication in the nuclear supply chain *Dave Gandy, EPRI, United States* (20mins+10 min discussion)
11:30 - 12:00	Advanced surface coatings in the nuclear supply chain *Alfons Weisenburger KIT, EU* (20mins+10 min discussion)
12:00 – 12:30	Panel Discussion (Presenters) led by Moderator (tbc)
12:30 - 14:00	Lunch
Session 3 – National Advanced Manufacturing Activities	
14:00 – 14:20	Advanced Manufacturing collaboration in the United States *Isabella Van Rooyen/Mark Messner*, DoE, (15mins+5 min discussion)
14:20 – 14:40	Advanced Manufacturing collaboration in the EU *Lorenzo Malerba*, CIEMAT, EU (15mins+5 min discussion)
14:40 - 15:00	Advanced Manufacturing collaboration in France *Eric Abonneau, CEA, France, EU* (15mins+5 min discussion)
Session 4 – Group Activity	
15:00 – 17:00 **includes Afternoon tea**	Split into 3 or 4 groups, which undertake following activities led by Moderator/Rapporteur a. identify potential collaborative AMME activities/projects b. analyze each identified area of collaboration (SWOT analyses?) c. prioritization of identified areas/ideas d. agree communication for Rapporteur to give to meeting (can develop presentation overnight)
17:00	End of Day 1
Wednesday 19 February	GIF AMME Workshop on Advanced Manufacturing **DAY 2**
Session 5 – Group Reporting and Meeting Outcomes	
09:00 - 10:30	Communally undertake following activities: a. Rapporteurs from each group presents group output b. Overall prioritization of potential collaborative AMME activities/projects c. Identification of next steps and way forward
10:30	End of Meeting

Lyndon Edwards

Chair of the AMME TF and all Contributors

RDTF: Research & Development Infrastructure Task Force

R&D infrastructure

Today's research infrastructure needs, from R&D to demonstration and deployment, includes major scientific equipment, scientific collections, structured information and ICT-based infrastructure. They are single-sited or distributed throughout several countries. GIF member countries are faced with a wide spectrum of issues related to infrastructure, many of which are globally unique and regionally distributed. Many stakeholders are involved, from ministries to researchers and industry, with an underlying and growing use of e-infrastructure. They present opportunities for, and yet difficulties in, interactions between basic research and industry. Public and private funding appears always to be lacking, and single countries do not have the critical mass or the dimensions to implement large research infrastructure. There is a real need to co-operate on a broad international level. Substantial research, development and demonstration (RD&D) of systems' conceptual/detailed design and analysis are needed. Refurbishment and/or construction of research infrastructure and facilities are increasingly complex and costly. An opportunity exists, by identifying the latest R&D needs and the mapping of infrastructure, to plan for the shared use of existing facilities and to undertake the development of others. The most important priorities are in the areas of fuel cycle, fuel and material irradiation, reactor safety, dedicated loops, mock-ups and test facilities, advanced simulation and validation tools, transnational access to infrastructures, the E&T and Knowledge Management (KM) of scientists and engineers. GIF members strongly support a co-ordinated revitalization of nuclear RD&D infrastructure worldwide, to a level that would once again quickly move forward a new generation of reactors.

Background/terms of reference

Background: At the 43rd GIF Policy Group (PG) meeting held on 13-14 April 2017 in Paris, France, it was decided to establish a new Task Force (TF) on R&D Infrastructure. The PG tasked the Technical Director (TD) to develop, in collaboration with the PG Vice Chair in charge of external collaboration and with the Technical Secretariat (TS), the Terms of Reference (ToR) for the GIF R&D Infrastructure Task Force (GIF RDTF). This Task Force is expected to accomplish its objectives over a short duration (less than two years) and make maximum benefit of the GIF Symposium held in October 2018.

Objectives: Identify essential R&D experimental facilities needed for development, demonstration and qualification of Gen-IV components and systems, including activities to meet safety and security objectives. To this end, the Task Force should prepare relevant presentations and papers for the October 2018 GIF Symposium.

Promote the utilization of the experimental facilities for collaborative R&D activities among the GIF partners. To this end, identify existing mechanisms and approaches, including organizational points of contact, for obtaining access to relevant R&D facilities in the GIF member countries. This information should be made accessible to GIF participants on the GIF website.

Organization: Each Gen-IV System Steering and provisional System Steering Committee (SSC and pSSC) designated one representative to the GIF RDTF. The task Force reports to the Technical Director (TD), the Expert Group (EG) for review, quality and completeness, and the Policy Group (PG). Members of the GIF RDTF meet as needed, taking advantage of teleconferences and GIF EG/PG venues. Chairpersons and a two-year work plan were agreed since their first meeting at OECD/NEA in Paris in February 2018. It included milestones and deliverables, with a recommendation to take full advantage of any relevant work from IAEA and NEA in the area of infrastructures. First objective was reached on time for presentation at the October 2018 GIF Symposium in Paris. The second objective, originally planned by spring 2019 was delayed, and upon completion of the two objectives of the GIF RDTF, SSCs and pSSCs will be expected to maintain cognizance of infrastructure needs and approaches for their access as work evolves from mid-2020 onwards.

Main achievements in 2019

Identification of existing experimental facilities in response to the aforementioned needs highlighted some gaps. Planned experimental infrastructure constructions, availability of experimental infrastructures outside the GIF countries were discussed.

An opportunity was also taken to propose any update of existing IAEA and NEA databases (including any new infrastructures or facilities launched) with the close support of GIF SSC (or pSSC) and EG groups. The Task Force benefitted from GIF Member State's latest relevant updates and R&D needs outlooks together with: a) IAEA database of Facilities in Support of Liquid Metal-cooled Fast Neutron Systems Facilities and its latest compendium; b) The Advanced Reactor Information System (ARIS); c) The Research Reactor database (RRDB); d) OECD/NEA Research and test facilities database (RTFDB); e) OECD/NEA Task Group on Advanced Experimental Facilities (TAREF) on SFR and GFR but also the Support Facilities for Existing and Advanced Reactors (SFEAR); and f) International Co-operation initiatives and collaborative projects (e.g. IAEA CRPs, ICERR, NEA joint projects, NEST, NI2050, and EU/Euratom projects) for building knowledge and facilities needed for the development of nuclear energy systems e.g. ADRIANA (ADvanced Reactor Initiative And Network Arrangement).

An opportunity to start interacting with NEA Working Group on Safety of Advanced Reactors WGSAR took place as from October 2018, to identify and address safety research needs, and to identify and resolve key regulatory issues.

IAEA Liquid Metal-cooled Fast Neutron Systems (LMFNS) database's update took place throughout the year 2019, by organizing a technical meeting in January, a joint workshop by the end of March, and updates on a case by case basis during the following months. To summarize, LMFNS has been updated as following: a) 43 facilities updated (22 LFR facilities and 21 SFR facilities); b) 34 new facilities added (16 SFR facilities and 18 LFR facilities); and c) now LMFNS Online Catalogue includes 180 facilities (86 SFRs, 80 LFRs, and 14 cross-cutting, for dual applications). IAEA LMFNS Online Catalogue is from now on publicly available at ***https://nucleus.iaea.org/sites/lmfns*** and it is online since August 2019. Any new update is welcome and dealt with on.

Similarly, IAEA Technical Meeting on Knowledge Preservation for Gas Cooled Reactor Technology and Experimental Facilities (GCR and HTR) database was launched in December 2018. IAEA and GIF RTDF members devoted efforts in compiling around 115 facilities identified. A database "GCR and HTR" has been produced in 2019, quality checks are taking place and a database could be available by mid-2020. As such, GIF RDTF participants welcome such existing databases' updates. IAEA should be able to update them on a two years' basis. GIF Policy Group should engage and give their full support.

A dedicated GIF RDTF report was drafted during 2019 and presented at the GIF EG/PG meeting in Weihai (CN). Three major sections still need to be completed namely: a) section IX – cross-cutting R&D infrastructures; b) section X – Mechanisms and approaches for collaborative R&D activities; and c) section XI – key recommendations. The objective will be to have a full draft report available for its review by the EG members, by May 2020, also integrating key recommendations of the following workshops.

GIF International Workshops with Nuclear Industry including SMR vendors and supply chain SMEs were organized successfully, with 60 high-level participants, on 18-20 February 2020, at OECD/NEA, in Boulogne-Billancourt, France. The first and half day, the Workshop was devoted on Advanced Manufacturing (see AMME report). The second half of the Workshop was on R&D Infrastructures needs and opportunities. It included roundtables: Engaging with the private sector, Identification of collaboration opportunities between private and public sectors for Gen-IV systems, a Networking Cocktail gathering both GIF representatives and Industry, Examples of collaboration between governmental organizations and industry, and views from the private sector, an Outlook for SMRs. GIF Policy Group Chair Hideki Kamide concluded the workshop together with representatives of industry, regulators, GIF Member States' and OECD/NEA representatives.

Conclusions (and/or Next steps)

The results show that there is a very real interest in both research institutions and nuclear companies within GIF countries in active collaboration supporting GIF member's organizations at the workshops. The main objective for 2020 is to finalize GIF RDTF report and any related database update. Way forward will also be discussed at the EG/PG meeting in May 2020, in Sydney, Australia.

GIF International Workshops with Nuclear Industry including SMR vendors and supply chain SMEs:

GIF workshop on R&D Infrastructures needs and opportunities

Wednesday 19 February 2020

- **11h00 - 11h15 Welcome**
  - Welcome by *Roger Garbil*, Euratom, DG RTD, Chair of the GIF R&D Task Force and *Sama Bilbao y Leon*, NEA
- **11h15 – 12h30 Engaging with the private sector – Round Table**
  Moderator: Sama Bilbao y Leon
  - R&D challenges for Gen IV systems, *Gilles Rodriguez*, CEA (GIF Technical Director)
  - GIF R&D infrastructures and large scale experimental programmes, *Roger Garbil*
  - GIF Advanced Manufacturing initiative, *Lyndon Edwards*
  - Regulatory challenges to license Gen IV systems, *Raj Iyengar*, Chief of the Component Integrity Branch, NRC's Office of Research
- **14h00 – 16h00 Identification of collaboration opportunities between private and public sectors for Gen IV systems**
  - 14h00 - 14h10 Introduction - *Roger Garbil*, Euratom, DG RTD, Chair of GIF R&D TF
  - 14h10 – 14h30 Example of a LWR-based Advanced Reactor development programme
  Moderator: Sang Ji Kim
  - *Fredrik Vitabäck*, GE-Hitachi, BWRX300
  - *Richard Wain*, UK SMR, Rolls Royce
  - *Jean-Michel Ruggieri*, Program Manager, SMRs, CEA, NUWARD Project
  - *Sang Ji Kim*, SMART Technology Development Division, KAERI, GIF EG member
  - *Marketa Krykova*, Project Manager, CVR, SSC SCWR co-Chair

  - 14h30 – 15h00 Molten Salt Reactors (MSR)
  Moderator: Stéphane Bourg
  - *David Leblanc*, President and CTO, Terrestrial Energy
  - *Stéphane Bourg*, CEA, GIF SSC Chair
  - *Lou Martinez Sancho*, CIO Kairos Power FHR (KP-FHR)
  - *Victor Ignatiev*, IPPE, MOSART project and related infrastructures
  - *Jan Uhlir* Update on Pu/Pr cooperation in CZ

  - 15h15 - 15h45 Liquid Metal Reactors (SFR and LFR)
  Moderator: Alessandro Alemberti
  - *Fausto Franceschini*,Westinghouse LFR,
  - *Alessandro Alemberti*, ANSALDO Nucleare, LFR SSC Chair,
  - *Jean-Marie Hamy*, Framatome, SFR
  - *Ilia Pakhomov*, Head of Laboratory, Russian Federation, Institute for Physics and Power Engineering (IPPE)

GIF International Workshops with Nuclear Industry including SMR vendors and supply chain SMEs:
Workshop on Advanced Manufacturing / Workshop on R&D Infrastructures needs and opportunities
18-19-20 February 2020, OECD/NEA – Boulogne-Billancourt, France

  - 15h45 – 16h15 Gas-cooled High Temperature Reactors (HTR)
  Moderator: Lyndon Edwards
  - *Jean-Marie Hamy*, Framatome, US SC-HTGR program
  - *Dominique Hittner*, USNC
  - *Karl-Fredrik Nilsson*, EU/Euratom JRC, Chair HTR SSC

  - 16h15 – 16h45 Cross-cutting topics, non-electric applications
  Moderator: Taiju SHIBATA
  - *John Jackson*, INL, National Reactor Innovation Center,
  - *François LE Naour*, CEA
  - *Taiju Shibata*, JAEA
  - *Abderrahim Al Mazouzi*, EDF

  - 16h45 – 17h30 Wrap-up and lessons learnt (Tech Director + Moderators)
  - All the moderators – Need to 2 bullet points + ½ page reporting

- **17h30 Networking Cocktail – GIF and Industry**
  - Making connections and fostering exchanges among GEN-IV systems and cross-cutting topics between: Public / Private sectors, R&D Organisms / Industry, R&D platforms.

Thursday 20 February:

- **9h00 – 11h00 Examples of collaboration between Governmental organisations and industry**
  - Welcome by GIF Vice Chair on R&D Collaboration, *Jong-Hyuk Baek*, KAERI
  - Panel discussion - *Moderator: Gilles Rodriguez*
  - *Gilles Rodriguez*, (on behalf of the CEA's Sodium School Director)
  - *John H. Jackson*, Acting Director, Gateway for Accelerated Innovation in Nuclear (GAIN)
  - *Tatiana Ivanova*, FIDES projects to address post-Halden situation / OECD
  - *Stefano Monti*, IAEA
  - *Raj Iyengar*, Chief of the Component Integrity Branch, NRC's Office of Research
  - *Stephen Bushby*, Atomic Energy of Canada Limited
  - *Iuliia Kusina*, Director, Institute for Physics and Power Engineering (IPPE)

- **11h30 – 12h30 Views from the Private Sector, an Outlook for SMRs**
  Moderator: Stefano Monti
  - *Fausto Franceschini*, Westinghouse LFR,
  - *Lou Martinez Sancho*, CIO Kairos Power FHR (KP-FHR),
  - *David Leblanc*, President and CTO, Terrestrial Energy,
  - *Robin Manley*, VP SMR Technology, Ontario Power Generation,
  - *Raj Iyengar*, Chief Component Integrity Branch, NRC's Office of Research,
  - *Dominique Hittner*, USNC,
  - *Richard Wain*, UK SMR, Rolls Royce
  - *Fredrik Vitabäck*, GE-Hitachi, BWRX300,
  - *Arkady Karneev*, Rosatom Western Europe

- **12h30 – 13h00 Workshop conclusions**
  GIF Policy Group Chair *Hideki Kamide*, representative of industry, representative of regulator, representative of OECD/NEA

- **13h00 Closing of the Workshop**

GIF International Workshops with Nuclear Industry including SMR vendors and supply chain SMEs:
Workshop on Advanced Manufacturing / Workshop on R&D Infrastructures needs and opportunities
18-19-20 February 2020, OECD/NEA – Boulogne-Billancourt, France

Roger Garbil

Chair of the RDTF TF and all Contributors