

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% of 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 field 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! <i>Lyndon Edwards, ANSTO, Australia</i>
09:30 - 10:00	The nuclear supply chain; past, present and future <i>Andrew Storer, NAMRC, UK</i> (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 <i>Kurt Terrani, ORNL, United States</i> (20mins+10 min discussion)
11:00 – 11:30	Innovative fabrication in the nuclear supply chain <i>Dave Gandy, EPRI, United States</i> (20mins+10 min discussion)
11:30 - 12:00	Advanced surface coatings in the nuclear supply chain <i>Alfons Weisenburger KIT, EU</i> (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 <i>Isabella Van Rooyen/Mark Messner, DoE,</i> (15mins+5 min discussion)
14:20 – 14:40	Advanced Manufacturing collaboration in the EU <i>Lorenzo Malerba, CIEMAT, EU</i> (15mins+5 min discussion)
14:40 - 15:00	Advanced Manufacturing collaboration in France <i>Eric Abonneau, CEA, France, EU</i> (15mins+5 min discussion)
Session 4 – Group Activity	
15:00 – 17:00	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)
includes Afternoon tea	
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