



Review of Advanced Manufacturing

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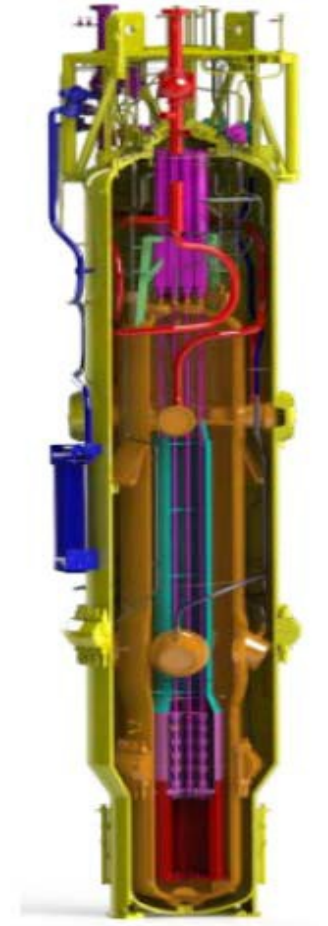
Outline

1. Background
2. Developing an understanding of AM
3. Engagement with industry partners
4. Action plan for advanced manufacturing (AM)
5. Codes and standards collaboration
6. Regulatory updates
7. Questions



Why would AM be of Interest to the Nuclear Industry?

- Produce replacement parts for the existing fleet with a very short turn around
 - Obsolete parts: some units are over 40 years old
- Produce new or complex parts for the new fleet of ALWRs, SMRs and Gen IV applications
- Design to include improved flow characteristics or special features that can't be achieved through casting/forging/ machining
- Introduce favorable properties via unique microstructures
- Design for performance
- Speed of delivery
- Cost reductions



Developing an understanding of AM



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- Research requests from the Office of Nuclear Reactor Regulation (NRR) and the Office of New Reactors (NRO)
 - NRC is developing an action plan which will include research of AM techniques
 - RES is looking to leverage the existing research and capabilities of DOE labs.
 - Understanding of:
 - Repeatability and control of AM processes
 - Quality and inspectability of AM-made parts
 - Service performance, degradation mechanisms, and aging of AM-made parts

Engagement with Industry Partners and other Regulatory Agencies



- NRC hosted a public workshop “Additive Manufacturing for Reactor Materials and Components”
 - Standardization activities
 - Research and applications in nuclear and other industry
 - Processes and capabilities
 - Technical and regulatory challenges
 - Developed NUREG/CP-0310 “Proceedings of the Public Meeting on Additive Manufacturing for Reactor Materials and Components”
- Developing an addendum to the EPRI MOU to allow for regular knowledge sharing
- Leveraging the capabilities and research being performed by the Department of Energy
- Participation in numerous conferences such as the NRC Vendor Forum, QNDE, and FAA-EASA Joint Workshop

EDO Innovation and Transformation Initiative



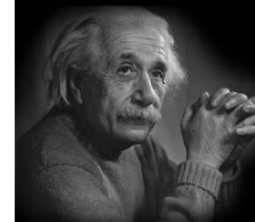
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- Innovation and Transformation at the NRC was the subject of a new initiative in 2018.
 - Taking a more proactive posture for emerging technologies was reflected in SECY-18-0060 issued on May 23, 2018, by the EDO to the NRC Commissioners. (publicly available at ML18110A186)
 - “New materials and manufacturing approaches” are identified in the context of emerging novel technologies
 - The NRC staff is pursuing early engagement with ongoing industry research into advanced manufacturing methods, such as additive manufacturing (AM).
 - Meanwhile, industry is planning to gain operating experience by initiating the use of AM in 2018 to fabricate components with low safety significance. The combination of building operating experience through limited low safety significance implementation and NRC engagement in research and codes and standards development is an ideal approach to ensuring the safe and secure use of new materials, which can provide the basis for future NRC approval in a broader range of applications.
 - The NRC is currently developing an advanced manufacturing action plan that will address appropriate guidance updates and other activities.

NRC Action Plan for AM

- To address NRC readiness for regulatory review of AM-made parts, in order to license their use in safety-related systems in nuclear applications
- To provide for interoffice coordination - reactors, waste management, research
- To continue engagement with codes and standards organizations
- A subject of NRC “Innovation and Transformation” initiative
- In early stages of development

One perspective...

**THE ONLY SOURCE
OF KNOWLEDGE IS
EXPERIENCE.**



Albert Einstein
German Theoretical-Physicist
(1879-1955)

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Codes and Standards Collaboration



- NRC is collaborating with codes and standards bodies as they work to develop standards for the use of AM-made components in the nuclear industry
- ASME Special Committee on use of Additive Manufacturing for Pressure Equipment
 - Next meeting: November 11-16, 2018 in Atlanta, GA
- ASTM E08, E07, and F42 committees
 - Next meeting: November 2018 in Washington D.C.

NRC Interests



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- Schedule and method for industry implementation
 - Licensing Topical Report process
 - License amendment process
 - 10 CFR 50.59 process
 - Timing of plant-specific implementation vis-à-vis codes/standards action and/or topical report approval will significantly affect review complexity
 - Volume of licensing actions
 - Could lead to prioritization of reviews

Path Forward for the NRC



- Develop an understanding of AM
- Continue collaboration with industry partners and DOE
- Continue participation in codes and standards activities
- Develop an action plan for AM

Questions?