Advanced Manufacturing Methods

NEI Roadmap on Regulatory Acceptance

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NUCLEAR ENERGY INSTITUTE

Goal of NEI's Roadmap

- Challenge: Advanced manufacturing methods rapidly maturing for use by nuclear industry; however, a timely and clear pathway to regulatory acceptance remains an obstacle for many methods
- Objectives:
  1. Identify the methods of most interest to industry – biggest benefits and nearest-term use
  2. Provide insight to organizations' assignment of resources toward furthering the commercialization of methods
  3. Establish clarity on an expedited pathway to regulatory acceptance

List of Methods

Additive Manufacturing – Metals

- Binder Jetting
- Direct Energy Deposition
- Direct Metal Laser Melting
- Electron Beam Direct Energy Deposition Wire
- Electron Beam Melting
- GTAW Direct Energy Deposition Wire
- Investment Casting
- Laser Direct Energy Deposition Wire
- Laser Engineered Net Shaping
- Laser Powder Bed
- Laser Powder Bed – Fusion
- Laser Wire Directed Deposition
- Powder Metallurgy Hot Isostatic Pressing
- Wire Plus Arc AM

Additive Manufacturing – Non-Metals

- Additive Layer Manufacturing
- Blown Powder Laser
- Electron Beam Freeform Fabrication
- Electron Beam Powder Bed
- Electron beam-enabled Advanced Manufacturing
- Laser Deposition Technology
- Laser Direct Energy Deposition Powder
- Laser Freeform Manufacturing Technology
- Material Extrusion
- Material Jetting
- Plasma Arc Directed Deposition
- Powder Bed Fusion
- Rapid Plasma Deposition
- Robocasting or Direct Ink Writing
- Selective Laser Melting
- Sheet Lamination
- Ultrasonic Additive Manufacturing

List of Methods (continued)

Joining
- Adaptive Feedback Welding
- Electron Beam Welding
- Friction Stir Welding
- Hybrid Laser Arc Welding
- Hybrid Laser-GMAW

Machining
- Advanced Machining
- Cryogenic Machining
- Ultrasonic Machining

Metallurgical Modification
- Equal channel angular pressing
- High-pressure torsion

Surface Modification/Cladding
- Cold Spray Additive Manufacturing
- Diode Laser Cladding
- Friction Stir Additive Manufacturing
- Hollow Cathode Plasma Nitriding
- Laser Cladding Technology
- Laser Peening
- Laser Surface Nitriding
- Nanocoatings

Supporting Technologies
- Advanced NDE Methods
- Improving weld quality through use of integrated optical sensors
- Real-time Flaw Detection
- Metrology Methods

Survey

- Results sortable by organization type (e.g., developer, manufacturer)
- Understand interest
  - Desired benefits (e.g., reduce cost, improved quality)
  - Applications (e.g., radiation environment, non-water coolant)
  - Types of components (e.g., vessels, pumps, fuel assembly)
  - Concerns (e.g., lack of qualification data, standards development)
- Identify for all methods
  - Importance based on potential benefits and scope of applicability
  - Urgency based on desired timeframe for using method

Regulatory Acceptance Pathways

- Current: NRC rulemaking to accept ASME code
- Challenge: Can take ASME years to incorporate into code, and then the NRC another few years to accept ASME code
- Proposed expedited pathways to accelerate NRC acceptance
  - Application (e.g., topical report, license amendment) includes method qualification and component qualification data
  - Two ways to provide method qualification data
    1. NRC adoption of ASME code case (e.g., interim staff guidance)
    2. Provided by applicant
  - Expected content of application (e.g., functions, environment, properties, performance, quality/repeatability,)

Next Steps

- March – NEI issues Roadmap