

Topics of Interest for Additive Manufacturing of Reactor Materials and Components

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November 29, 2017

Topic Areas

- Quality of AM materials and components for NPPs
- Codes and standards aspects of AM
- Properties and structural performance
- Service performance / aging degradation
- Cyber security

But First – For NRC Planning Purposes

- Schedule for industry implementation of AM
 - 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
- Scope of actions that are of interest to NRC – similar to License Renewal
 - safety-related systems, structures, and components (SSCs)
 - all nonsafety-related SSCs whose failure could adversely impact functionality of safety-related SSCs
 - SSCs relied on in certain safety analyses or plant evaluations for specific NRC regulations.

Quality of AM Parts for NPPs

- AM Build Process
 - Critical parameters
 - Directionality
 - Uniformity
 - Residual stresses
 - Surface roughness
 - Density
 - Powder reuse
- Post-Build Processing
 - Densification (e.g., Hot Isostatic Pressing)
 - Annealing
 - Surface processing

Codes and Standards Aspects of AM

- American Society of Mechanical Engineers (ASME)
- ASTM International
 - formerly American Society for Testing and Materials
- American National Standards Institute (ANSI)
- American Society for Nondestructive Testing (ASNT)
- NACE International
 - formerly National Association of Corrosion Engineers

Properties and Structural Performance

- Properties
 - As-built
 - After post-build processing
 - Coupons vs. component
 - Fatigue performance
 - Comparison to conventional manufacturing methods
- Defect Characteristics/Populations
 - Type
 - Size
 - Density
 - Impact on structural integrity

Properties and Structural Performance

- Inspectability
 - In-process examinations
 - Methods capable of finding structurally relevant defects
 - Pre-service inspections
 - Inservice inspections

Service Performance / Aging Degradation

- In various service environments
 - Aqueous
 - Corrosion
 - Stress corrosion cracking (SCC)
 - Environmental fatigue life
 - Environmental fatigue crack growth
 - Neutron effects
 - Loss of fracture toughness
 - Swelling
 - IASCC
 - Thermal effects
 - Loss of fracture toughness
 - Thermal expansion

Summary

- Additive Manufacturing has been identified as an area of potential future utilization by the nuclear industry – “when” and “how many” are the questions
- NRC interest areas
 - The quality of AM parts
 - The properties of AM parts
 - The structural performance of AM parts, including their inspectability
 - The service performance and aging degradation of AM parts
- Codes and standards aspects of AM is a key to successful implementation
- Comparison of performance of parts from AM and conventional manufacturing process